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MEETING OF APRIL 30, MAY 1 and 2, 1928

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ADDRESS OF THE PRESIDENT
EARLY HISTORY OF MEDICAL EDUCATION IN CALIFORNIA
By EMMET RIXFORD, M.D.
OF SAN FRANCISCO, CALIFORNIA

THE early history of medical education in California is bound up with the lives of three remarkable men—three surgeons—one for many years a Fellow of the American Surgical Association. It partakes of the romance of pioneer days and savors of the gold rush.

The men who braved the dangers and the hardships of the long journey round the Horn, or traversed on horseback or on foot the two thousand miles across the great American desert from the Missouri river to the Pacific, were a hardy lot—weaklings could not keep the pace. These pioneers made a colorful group coming as they did from all walks of life.

Following those who came to dig gold were others who came to prey upon them: gamblers, bandits, thieves—criminals in wide variety. With almost no law but lynch law, men had to stand on their own feet; and individual character speedily came forward and took things into its own hands. But there was much more decency than knavery.

In a country in which stage robbery was almost an honorable profession, the doctor was immune to banditry, because it was tacitly understood that if a stage robber happened to be wounded, the doctor would attend him and not divulge the fact nor the bandit's hiding place to the authorities.

In this heterogeneous company there came a fair sprinkling of fine young men of good family, many just out of college, attracted by the very romance of going to California; some of them trained in the professions of law, medicine and theology. These men left an indelible impression on the community and California owes them an immeasurable debt; for many of them recognized their opportunities for constructive work in the fair new state and remained to "grow up with the country".

In the open places all those who had the slightest knowledge of medicine were called on to help the sick and wounded; malaria particularly and typhoid kept them busy. The man without a diploma who could give a dose of physic or of quinine or iodide of potash held almost as high a position in the com-

munity as did the trained physician. But the physician with a diploma, no matter how easily it had been secured, looked down with scorn on the self-made doctor. It soon became a time of rigid medical ethics; perhaps because hard and fast rules were found to be a necessity when so much in practice was a matter of opinion and precedent instead of knowledge, for bacteria had not yet been discovered and the dissecting room was the only laboratory. Jealousy was fierce and rivalry and competition keen.

Into such a community in 1855 came Dr. Elias Samuel Cooper, scion of a race of strong men of pioneering spirit, implacable as enemies but equally strong in the making of lasting friendships. An older brother was a physician active in Galesburg, Ill., a younger brother became Professor of Greek and Hebrew in Rutgers College, N. J. It is perhaps evidence of the strength of the Cooper character that all nine children of an older sister (mother of Levi Cooper Lane), had "Cooper" for a middle name.

Born in 1822, in Somerville, Ohio, Cooper began the study of medicine at the age of sixteen in Cincinnati but was graduated in 1840 by St. Louis University—a school which has long since passed out of existence. He began practice in Danville, Ohio, at nineteen and in 1844 moved to Peoria, Ill. He built the first hospital in Peoria, a three story brick building which was called by the children of the neighborhood "The Spook House". He was all but run out of Peoria because he maintained an anatomical museum and dissecting room above his office, where he worked nights to perfect himself in anatomy that he might be familiar with the anatomical detail of his operative fields. Of course most of the cadavers were surreptitiously obtained. Some supersensitive citizens resented the row of human skeletons which lined the wall and when the County Authorities publicly turned over to Doctor Cooper the bodies of two murderers—victims of the first execution in Knox County, a mass meeting of irate citizens was held but the meeting broke up in a near riot and the matter was quashed.

Elias Samuel Cooper

Returning from a trip to Europe he brought with him a quantity of chloroform, and is generally credited with having been the first to use chloroform in anæsthesia in the Mississippi Valley. In 1851, he read a paper before the Illinois State Medical Society, entitled, "The Effect of Chloroform as an Anæsthetic Agent in 79 Surgical Operations". He was vice-president of the society in 1852, president of the Knox County, Ill., Medical Society in 1853.

Doctor Cooper greatly admired Brainerd, founder of Rush Medical College and conceived the ambition of emulating him and founding a medical college on the Pacific Coast. He sailed for Portland, Oregon, but on the steamer met one Captain James M. McDonald who prevailed upon him to leave the ship at San Francisco. I mention "Captain Jim" as we afterward called him; because, out of this friendship for Doctor Cooper and thirty years after Cooper's death, he gave to Cooper College the land on which Lane Hospital stands, as well as a substantial sum in money.

Arriving in California at the age of thirty-three, Cooper was almost immediately active in organizing a state medical society—he was one of those who issued the invitation to the medical profession to assemble for the purpose. He was said by a contemporary to have been the very life of the undertaking. He was an aggressive man who could not be accused of hiding his light under a bushel, for he advertised widely his Ophthalmic and Orthopædic Dispensary in the several score of newspapers of the mining districts. This list of newspapers as revealed by his receipts would be an antiquarian's delight; one, "The Wide West", was published on board an abandoned steamer of that name laid up on the mud in San Francisco harbor. In his dispensary all operations were free to patients presenting themselves on Wednesday and Saturday afternoons and medical men were invited to visit the infirmary on clinic days. These advertising methods were brought up in the Pathological Society and Doctor Cooper was severely criticised by the President. Cooper who was present strode to the chair, shook his fist in the President's face and threatened to thrash him if he uttered another word against him. Dr. A. J. Bowie, a scholar and polished gentleman, a southerner who believed in the code, did his best to arrange a duel, offering the President his services as second so that the insult might be wiped out, but the President's valor oozed out in the drink emporium nearby, whereupon Doctor Bowie changed sides and became a fast friend of Doctor Cooper. Not long after Cooper started his medical school Bowie became Professor of Clinical Medicine.

Cooper * was a fearless surgeon of great originality and with but little education, a demon for work he slept but four hours in the twenty-four. He looked upon surgery as the only field of endeavor worthy of a man. He successfully sutured the fractured olecranon and patella with silver wire, treated refractory club-foot by cutting the soft parts on the contracted side as did Phelps of New York forty years afterward, and, not having plaster-

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* Doctor Cooper's contributions were published chiefly in the *Northwestern Medical and Surgical Journal*, 1853, *Pacific Medical and Surgical Journal*, 1858, *California State Journal of Medicine*, 1856–7, *Transactions of the Medical Society of California*, 1858, *San Francisco Medical Press*, which Doctor Cooper founded in 1860.

of-Paris bandages, held the foot in a splint of sheet lead moulded to fit. He advocated early functional demand in fractures and certain diseases of joints, devising an apparatus for the leg which he called the "spring boot" which permitted the patient to walk. He announced a new cure for aneurism :— cutting down on the tumor and sewing it up from the outside.

Having accidentally torn the iliac vein when ligating the external iliac artery for femoral aneurism, he ligated both vein and artery and observed that the limb retained its warmth. The man recovered with a serviceable leg. Cooper then made a series of experiments on the dog, in some ligating the vein alone, in others the artery and in still others both vessels ; and found that the limb remained warmer when both vessels were tied than when only one was ligated. He devised an instrument for the gradual obliteration of the abdominal aorta and used it with some degree of success on the dog. He declaimed against the fallacy of fearing the entrance of "atmosphere" into joints, maintaining that the best treatment of small wounds of joints was to lay the joints wide open and pack with lint. He orated on the fact that his wounds healed better in California than in Illinois, accounting for the difference by the combination of climate with the use of alcohol; for he washed out his wounds with 25 per cent. alcohol. He performed the first Cæsarean section in California at a time when the mortality of the mother was 50 per cent. of the reported cases. And the woman lived.

The account of the case published in the *Pacific Medical and Surgical Journal* by the editor who had been called in consultation and assisted in the operation, gives such a picture of the surgery of the time that it may not be amiss to digress a bit to quote from it.

> The woman was in the thirties, primipara, had been in labor for forty hours, occipito-posterior presentation, the head in sight. Doctor Cooper could not account for the delay except on the assumption of interlocked twins. "After further delay," the editor says, "we operated, he (Doctor Cooper) using the knife, . . . through an incision in the axis of the body between the recti muscles. We found but one fetus, the one which had been in sight twenty hours. It weighed eleven and one-half pounds, enough for two but only one. . . . After various changes and alternations between life and death the patient finally recovered so as to be able to walk in about forty days. The treatment was diaphoretics, apperients, opiates, carminatives, tonics, stimulants, etc., according to symptoms. After the middle of the fourth day she had porter, California wine, bottled soda, eggs, small birds, mutton chops, loin steaks, rice, etc., as much as she desired. The first three days a single thickness of domestic moistened in cold water is applied to the exposed abdomen to get the refrigerating action of evaporation. As soon as suppuration is established this dressing is replaced by a warm poultice of bread and milk until she is well. A weak solution of chloride of soda, (probably chlorinated soda or Labarraque solution) was several times injected through the vagina into the womb from which it issued from the abdominal wound . . . These cleansings diminished very much the almost gangrenous fetor of the first days of suppuration. The abdominal flatus was drawn off by an œsophagus tube per rectum."

In short the woman recovered. The editor, jealous of Doctor Cooper's reporting the case, wrote a scathing criticism of the error in diagnosis of twins, with the result that the most viciously fought malpractice suit of the California courts followed. The editor was the prosecuting witness.

The matter of medical education in California was brought up in the state

society; and at its second meeting, February, 1857, a committee on the subject, Dr. John F. Morse chairman, reported:

"We have no schools in which medical science is being taught nor are there any immediate indications of the practicability of the founding or the sustaining of such institutions. And it is not probable that any elaborate views upon the general relation of the subject will particularly influence those who are now annually engaged in sending out graduates from eastern schools. One thing, however, might be called to the attention of medical educators, viz., the advantages which would arise from a greater professional interest in the acquirement of modern languages. In no country in the world is there such an admixture of languages as in this state and consequently none in which the necessity is so forcibly suggested. A slight knowledge of German, French and Spanish is almost indispensable to the comfort of practitioners . . . Why men should cling to a system of education which requires years of youthful life devoted to an acquirement of the Hebrew, Greek and Latin languages, the first two of which survive the act of graduation only by some nearly miraculous combination of influences, at the same time that German, French and Spanish are almost utterly neglected, is one of those mysteries which can find no explanation in the common sense of mankind and no apology in any consideration of humanity and social kindness.

"As long as municipal governments regard hospitals as institutions in which the principal object seems to be to show the extent to which a bone-gnawing and washing-saving economy can be inflicted upon the impoverished sick, without any broad demonstrations of murder; so long as popular sentiment requires the managers of these asylums of benevolence to reduce the compensation for medical attendance to a parsimonious pittance; so long as the soul-crushing and heart-withering maxim 'buy cheap and dispense sparingly' is written upon every feature of these institutions, cheap buildings and cheap furniture, cheap bedding and cheap food, cheap physicians and cheap nurses, cheap medicines and cheap instruments, no books and cheap coffins; so long as these are the characteristics that distinguish the popular spirit of American, or perhaps more properly speaking of California philanthropy, so long will it be a useless thing to attempt the establishment of clinical schools of medicine which are the natural and proper nurseries of a complete medical education."

In the very next year, 1858, Cooper started his long projected medical school amid much ridicule on the part of the educated medical public, and which the aforesaid assistant and editor called the "Cooper Shop"; and Morse, the writer of the Committee's report just cited, not long afterward joined the faculty. There were well educated and strong men in the group which is said to have met by schedule in Doctor Cooper's office and lectured to each other in default of students. The faculty consisted at first of four doctors and one lawyer, Cooper being Professor of Anatomy and Surgery. R. Beverly Cole, (later President of the American Medical Association) was Professor of Obstetrics and Diseases of Women and Children and Physiology. He was also dean. In his enthusiasm for the new undertaking Doctor Cole urged moving into more elaborate rooms, offering personally to pay the rent. They moved into commodious quarters in Union Hall, Howard Street, San Francisco, over the street car barns; but Cole soon tired of the bargain and the school moved back to its rent free attic.

In default of a charter the school derived its right to issue diplomas from the University of the Pacific, a Methodist institution located at Santa Clara, California, and was named the Medical Department of the University of the Pacific. Dr. J. Morison, Professor of Principles and Practice of Medicine

and Pathology in the school was a member of the Board of Trustees of the University.

In the announcement of the first course of lectures to students which began May 12, 1859, occurs the following remarkable proposal for the course in surgery. "First, A regular course of lectures on the principles and practice of surgery; second, demonstrative surgery upon the cadaver; third, experimental surgery by vivisection, in which many of the most important principles are indelibly impressed upon the mind of the student. Members of the class are permitted to assist in these experiments upon animals and afterward expected to repeat them under the eye of the Professor of Surgery. This is an exercise above all others calculated to school the hand, the nerve and the eye of the pupil, and thereby give him the experience he at once requires in performing the duties of an operative surgeon; a feature in medical education, however, almost entirely neglected in many other medical schools."

The course of instruction consisted of five months' lectures repeated in a second year. The fee of each professor was $20 payable in advance, matriculation fee paid but once, $5, with graduation fee of $50.

In 1859, Dr. L. C. Lane joined the faculty as Professor of Physiology; in 1862, Bowie, of the duelling incident, as Professor of Theory and Practice of Medicine.

In 1862, Doctor Cooper died. He was only forty years of age. He was succeeded as Professor of Surgery by Bowie, and in 1863, Henry Gibbons, formerly of Wilmington, Delaware, joined the faculty, taking the chair of Materia Medica and Botany, and J. F. Morse, former editor and publisher of the *California State Journal of Medicine,* accepted the chair of Medicine.

In 1859, the school graduated two students (with ad eundem degree); in 1860, one; in 1861, 5; in 1863, 8; and in 1864, 7; 28 in all.

In 1864, Dr. H. H. Toland founded a new medical school which bore his name. He had erected a commodious building of brick and stone and furnished it at a total cost said by his biographer to have approximated $100,000. With so imposing a building, the Toland school was launched with great éclat while the old school, lacking the stimulating spirit of Doctor Cooper, was moribund. It ceased its activities and all the students entered Toland and formed a working nucleus for the new school.

The students petitioned the faculty to invite Doctors Lane and Gibbons to join the school. This was done and Lane was appointed Professor of Physiology and Gibbons of Medicine. Dr. Beverly Cole, being persona non grata to Doctor Toland, was not invited.

Dr. Hugh Hughes Toland, born in North Carolina, April 16, 1806, of Scotch-Irish parentage, was a notable figure in Pacific Coast medicine and surgery. Graduating from the Transylvania University of Lexington, Ky., in 1828, he began practice in his native state. In two years he went to France with $3,000 where he attended lectures and clinics for two and a half years, passing through the cholera epidemic of 1832. Returning to his native state he enjoyed an increasing practice during several years.

In 1852, he yielded to the call of the gold fields, shipped out a fully equipped stamp mill, one of the first to reach California, and bought the Gwyn mine in Calaveras County, California. But mining was not for him. He sold out after a year and entered the practice of medicine in San Francisco (1853). He rapidly rose in prominence so that by 1861 his annual income from practice passed the $40,000 mark, a tidy sum for those days. Without question Doctor Toland received a larger income from his profession than any other practitioner of his day in California and I doubt if anyone has equalled it since.

A striking figure— tall, erect, spare but with large frame, hair falling nearly to his shoulders, upper lip and chin shaved as far as the hyoid—below that a ruff of brown beard which made a wonderful muffler; straight nose, half closed eyes, straight mouth drooping a bit at the corners and massive jaws; he would attract attention anywhere.

He kept office hours in the morning for private patients; in the afternoon for clinic patients. Time and again I have seen his waiting room crowded as in a modern public clinic; often a hundred patients

H. H. Toland

in an afternoon. No charge was made for the examination of these patients nor for the prescription; but at the end of the corridor next the stairs was Doctor Toland's drug store and none but his pharmacist could decipher the scrawls of that squeaking quill pen. Some idea of the volume of the business done by this drug store could be obtained from a glimpse at the row of scrap books on the top shelf which encircled the room—a veritable frieze of huge books of prescriptions. This drug store was a real gold mine. It is interesting to note too that Doctor Toland did an enormous mail order business. People in the mines of California and Nevada found it easier to write an account of their symptoms to Doctor Toland than to make the long journey by stage to see him. Medicine was forwarded by express, and Wells, Fargo and Company collected the fee. Toland died suddenly, presumably

of apoplexy, in 1880, at the age of seventy-four, leaving an estate of nearly two million dollars.

Immersed as he was in practice, he had little time for original work; but produced a few clinical papers published chiefly in the *Pacific Medical and Surgical Journal,* and wrote a book on practical surgery.

For six years the Toland Medical College waxed strong; but serious differences in policy arose particularly concerning the election of new men to the faculty, and finally culminated in 1870 in the resignation of Lane and Gibbons, who thereupon re-organized the old school. Of the original faculty Bowie and Morse lent their names as professors emeritus, Gibbons was Professor of Medicine, Lane of Surgery, Cole of Diseases of Women and Children. To these were added Edwin Bentley, an ex-army surgeon, as Professor of Anatomy, Clinton Cushing in Obstetrics, Thomas Price in Chemistry. Henry Gibbons, Jr., served as dean and continued in that office for forty years.

All the students but one followed Lane and Gibbons. Toland, left with but one student, moved Heaven and Earth to get the students back; tried to effect a reconciliation, but Lane was not the man to alter a decision once made. Toland even made overtures to Doctor Cole, for the latter was always popular with the students. Not a student budged, but Cole became Professor of Physiology and Dean. He remained with the Toland school and served as dean for many years. This incident was the beginning of a long continued rivalry between the two schools; not always free of bitterness. Lane never forgave Cole.

After an uphill struggle for two years, the Toland school became affiliated with the University of California. Toland stipulated that the medical faculty preserve its autonomy, that he be professor of surgery for life and have the right to nominate his successor. This last condition, however, was not acceptable to the regents of the University. The property was eventually transferred to the University and the school became the Medical Department of the University of California and has remained such till the present day.

The Lane and Gibbons school, having excellent teachers and most of the students, lived by virtue of the quality of its teaching and the sheer force of character of its faculty. Authority for granting degrees was obtained by affiliation with University (City) College so-called, a Presbyterian school founded some sixteen years before and located in the heart of San Francisco; its grounds "forever dedicated to educational purposes" but alas! this block on the southeast corner of Stockton and Geary Streets now carries a great retail department store (The City of Paris). After a time the school took again the old name—Medical College of the Pacific.

In return for the authority to issue diplomas, two students nominated by the Presbyterian Church were to be given free tuition in the medical school each year in preparation for life as missionaries. This arrangement was continued by the medical faculty till about 1895, long after the University

College ceased to exist, in fact some twelve or thirteen years after the school became Cooper Medical College (1882).

In contrast to Cooper and Toland, Lane was a highly educated man. With a better preliminary education, he continued to be a student throughout his long life. Never robust, it was by sheer force of will and self discipline, and by dividing his sleep, that he formed the habit of using six or seven hours in the middle of the night for study. Six nights in the week he read medicine and did his writing, the seventh night he read in general literature. Thus he was widely read, especially in the literature of surgery in the nineteenth century. He was fond of the classics, read Greek and Latin, also French, German, and Spanish. He translated Billroth's Surgical Pathology for his students, laboriously writing it out in long hand in blank books, finishing this or that chapter at three or four in the morning. He read Hippocrates once a year in the Greek.

Levi Cooper Lane, born in Ohio, May 9, 1829 (or 1830), of English Quaker parentage, had some preliminary training at Farmer's College near Cincinnati and later attended Union College, Schenectady, N. Y. This institution later granted him the degree of M. A., and in 1877, LL.D.

He was graduated in medicine from Jefferson in 1851, and spent the following four years as interne and house officer at Ward's Island, N. Y. In 1855, he passed examinations for entrance to the United States Navy, his record remaining as the highest in navy examinations for many years. His thesis on External Urethrotomy was submitted in Latin. For a time he was stationed at the great naval hospital at Quarantine, Staten Island, N. Y., where, he always said, he learned to know typhoid fever. In fact he was himself desperately ill with it. When on sea duty, his ship was stationed on the coast of Central America where he learned Spanish. At Chinandagua, Nicaragua, he performed his first operation for goitre (1858). Incidentally it may be mentioned the ship became the refuge of some of the members of the Walker filibustering expedition in Nicaragua.

Resigning from the Navy in 1859, he joined his uncle Elias Cooper in practice in San Francisco, and at once entered the medical school as Professor of Physiology.

Like most of his contemporaries, Doctor Lane practiced both medicine and surgery. He was possessed of rare good judgment. He was not as original in his surgery as his uncle Elias Cooper, but he worked out vaginal hysterectomy as an original anatomical study (1878), not knowing that the operation had been done in the early years of the nineteenth century in France and had been forgotten. He anticipated Lannelongue in performing craniectomy for microcephaly. He was essentially a student and an organizer. For more than twenty years he had the cream of surgical practice on the Pacific Coast. From Alaska to Chili and from the Pacific to the Rocky Mountains, he drew his patients. He projected an elaborate text-book on surgery in three volumes but lived to finish only the first—"Surgery of the Head and Neck",—a volume unfortunate in form and in the time of
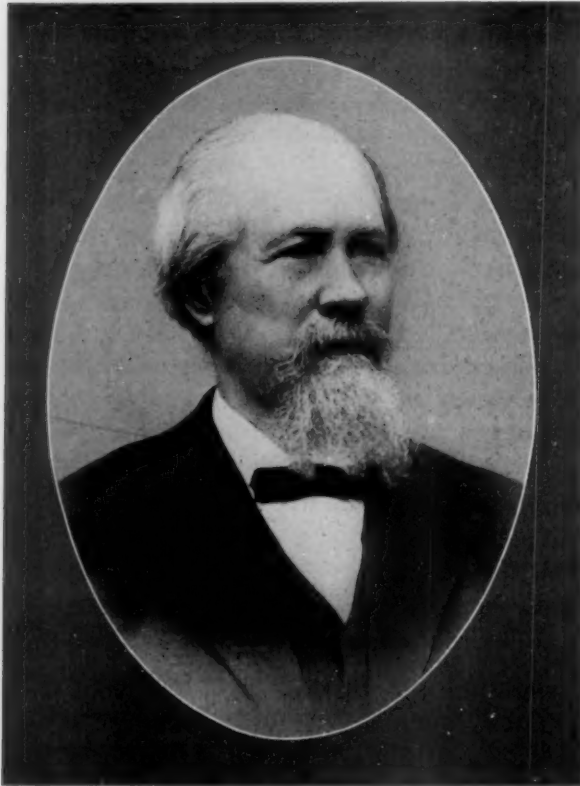
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its appearance—it was too late. Still it remains a mine of information with an atmosphere possessed by few text-books, of personal opinion based on long experience.

In 1882, Doctor Lane unknown to, and therefore without the advice of his faculty, erected a splendid brick building somewhat of the proportions of Rush Medical College; and invited the faculty to join him in re-organizing the school which should thenceforth be named Cooper Medical College in honor of his uncle and in memory of his having founded the first medical school on the Pacific Coast. He made one other condition which is peculiarly interesting: viz., that there should be given annually in the college a course of public medical lectures.

In his announcement of the lectures he said, "In the creation of this course the founder has entertained the hope that besides being a public utility it would tend somewhat to relieve Medicine of the complaint of exclusiveness often charged against it—of neglecting to contribute its quota to the diffusion of knowledge in those departments of science with which medical men are familiar". Again, "A majority of these lectures will be on matters of public health, but some of more scientific character, it is believed, may aid in dispelling the errors popu-

Levi Cooper Lane

larly prevalent that our profession is making no advances; and show to the contrary that no scientist is working more faithfully than the medical; and that in no department of science are more new tracts of knowledge being added than in the medical". In thus breaking away from the hitherto nearly universal attitude of the medical profession that it was the part of the public meekly to take its medicine, Doctor Lane was far ahead of his time. He realized that the day of the mystery of medicine was passing; and that the greatest aid to the physician in serving the public was the intelligent coöperation of the informed patient. He was hounded, however, in the local medical society and otherwise severely criticised.

In 1896 he founded a course of Medical Lectures designed to bring the Profession of the far west into closer contact with the more progressive minds in medical Europe and Eastern America. How well he succeeded is attested by the extraordinary prominence of those who have consented to give these lectures. The brilliant series of lectures of Professor Macewen of Glasgow on the Surgery of the Brain, with which the course was inaugurated, at once impressed the medical world with the seriousness of the undertaking, and made it possible for such men as Sir Michael Foster, Christopher Heath, Sir Thomas Clifford Allbutt, Sir Charles B. Ball, Wm. E. Welch, Reginald Heber Fitz, Vittorio Putti and many others of similar attainment to accept the invitation. As one might easily foresee, the lectures have proved to be of great educational value and a source of inspiration not merely to the students of Cooper College but to the medical profession as well. The lectures are now given biennially.

Doctor Lane built and gave to the college a second building equal in size to the first, and erected Lane Hospital (1894), containing some 150 beds. On a tablet in the vestibule he had inscribed the following: "This building erected by Levi Cooper Lane with moneys earned by himself in his profession, is dedicated to suffering humanity and to the medical profession in the hope that the former may here find refuge and relief and the latter exercise of its humane skill and intelligent sympathy."

Doctor Lane never grasped the technic of antiseptic or aseptic surgery. This he realized for á propos of it he often said "You can't teach an old dog new tricks". Yet he thoroughly believed in the antiseptic idea, e.g., he was bound that no germ should come into Lane Hospital. Every visitor, doctor and patient on entering was required to put on a pair of clean rubber overshoes. Again, it is pathetic rather than amusing to realize that to keep the operating room pure Doctor Lane bought a barrel of bichloride of mercury and had it incorporated in the plaster on the walls.

Doctor Lane and his faculty had labored unselfishly to build up Cooper Medical College; there was no stock and no dividends; even no salaries until in time laboratory courses were developed. Doctor Lane felt that such devotion as he and his friends had given would serve to keep the institution alive and active for all time; and so in the deeds to the property, he had inserted clauses to the effect that if the college should at any time unite with any other institution the property should revert to the state. But before he died he realized that the cost of medical education must so increase with the development of laboratories that the small endowment thus far secured would be utterly inadequate, and the students could not be expected to pay more than a fraction of the cost of their training. He therefore caused the entire property to be deeded back to him whereupon he re-deeded it to the college without these restrictive clauses. More than that, in conversation with Dr. David Starr Jordan, then president of Stanford University, Doctor Lane paved the way for the absorption of the college into Stanford University.

Against much opposition from many sources, perhaps better not men-

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tioned here, the amalgamation was effected in 1909. In turning over to Stanford University the college property, including Lane Medical Library, the only conditions made by the directors of Cooper Medical College (who felt themselves trustees of Doctor Lane's memory) were that the property should be used for the purposes of medical education in the sense of teaching young men and young women to be practitioners of medicine; and, second, that Doctor Lane's memory should be suitably preserved. Cooper College Faculty continued till 1912 in order to complete its contract with the matriculants then in the student body.

Doctor Lane died in 1902. His wife, the sole beneficiary under his will, survived him only six months; she left one-third of the estate to the college for a medical library—all she could leave under the law of California to a charity—and the remaining two-thirds to the then president of the college and, be it said to his shame, Professor of Ethics, who accepted the gift and retained it as, to be sure, he had a legal right to do. The two-thirds of the property were then worth a third of a million dollars and have perhaps doubled in value since. I can now imagine Doctor Lane, if he could be conscious of earthly events, censuring me for thus mentioning this matter for it might rescue his false friend from oblivion. I wish I had the power to convey Doctor Lane's conception of oblivion. To him oblivion was wonderful in the completeness of its annihilation!

It is often thought that Doctor Cooper left his nephew a fortune for the medical school. As a matter of fact Doctor Cooper's small estate, some $30,000, was distributed entirely to relatives in the East; and all that Doctor Lane inherited from this source was a few pieces of furniture, some surgical instruments and a number of belated bills which he personally paid.

Doctor Lane had a sentimental side which was little appreciated but which sometimes took a form that may now seem strange. He carefully preserved in alcohol Doctor Cooper's heart and brain and put them in an inner sanctum in the college where they still remain as a kind of monument to his uncle's ambitions in medical education. Doctor Lane's family inheritance from his mother's estate was but eighty dollars which he used to purchase the pedestal on which Doctor Cooper's heart and brain rest.

Now, after the passing of these picturesque and constructive figures, animosities are dead, the old fights are forgotten and the faculties of the two university medical schools in California have but a friendly rivalry in the effort to do better work for the benefit of the medical profession and for medical science.

But in this change while much has been gained have we not lost something? A colleague put it "Then man was big and science small—now science is big and man is small." That is just it. In our modern educational system are we not becoming swamped in the teaching of the infinite detail of scientific fact, perhaps forgetful that the best legacy a college can give its graduates is inspiration for work and thought, and the development of character and sympathy as a motive in the relief of human suffering?

SOME FUNDAMENTAL CHARACTERISTICS OF THE SPLEEN AND THEIR RELATION TO FUNCTION

By William L. Robinson, M.B., (Tor.) (By Invitation)

of Toronto, Canada

FROM THE DEPARTMENT OF PATHOLOGY, UNIVERSITY OF TORONTO, AND THE TORONTO GENERAL HOSPITAL

A histological study of the distended spleen after various injection experiments, seems to indicate that the spleen's chief function is that of filtration. It is essentially a vast spongy network of pulp cells which are reticulo-endothelial in type and function. These cells are surrounded by a capsule and supported by a trabecular framework made up of fibrous, muscle, and elastic tissue. It is capable of considerable variations in size and may hold in its meshes a fair portion of the total blood volume. The trabeculæ have firm attachments to the capsule on one hand and to the walls of the veins on the other. This allows, on contraction, for compression of the pulp tissue and distention of the veins. The flow of blood through the spleen appears to be more or less controlled by the relaxations and contractions of the capsule and trabecular framework.

The nature of the blood flow through the spleen is different from that of any other organ in the body. The arterial system is independent of the venous. The terminal arterial capillaries open out and discharge the blood elements into the pulp spaces. In this manner the blood is brought into direct contact with the reticulo-endothelial cells making up the pulp. It is forced from here into the venous sinuses by the contractions of the capsule and trabeculæ, gaining entrance to the venous channels through slit-like stomata in their bell-shaped openings at the beginnings of some of the shorter branches. The circulation therefore is an open one. The purpose of this type of circulation is obviously to bring the blood elements into direct contact with the reticulo-endothelial cells in order that they may exercise their known function, namely phagocytosis of foreign elements. Before phagocytosis can occur the foreign particles must adhere to the phagocytic cell. The mechanism by which this occurs represents an interesting problem in filtration. One might describe a filter as something which separates particulate matter from its fluid menstruum. While this may be true the mechanism by which it takes place is not simple. Berkefeld and Chamberlain filters were long thought to filter bacteria because of the smallness of their pores. Beckhold's original formula for determining the mean diameter of the pores would seem to substantiate this view. Using this formula Mudd calculated the mean diameter of the pores of a series of Berkefeld and Chamberlain filters, to vary between 0.38 and 0.45 u. Bigelow and Bartell, however, have shown an error of one decimal point in this formula, which makes the diameter of the pores ten times larger than that calculated with Beckhold's formula. With the cor-

rection we see that the mean diameter of the pores of Berkefeld and Chamberlain filters varies between 3.8 and 4.5 u. Pores of this diameter are plenty large enough for the passage of most bacteria. Such being the case there must be some other explanation of this phenomena of filtration. Mudd has suggested and proved that it is dependent upon the electrical charge of the wall of the filter pore. On their walls there is a Helmholtz double layer. Filtration occurs by the process of adsorption of the bacteria to the wall of the filter pore. This occurs when the electrical charge of the bacteria or particulate matter is opposite to that of the wall of the pores. The walls of the Berkefeld and Chamberlain filters, which are made up of siliceous material, carry negative charges and therefore filter out positively charged particles. This theory has been further substantiated by Kramer who made a filter of plaster-of-Paris. The presence of calcium carbonate in the commercial product gave a positive charge to the walls of this filter and with this he was able to filter out colloidal substances which passed through the siliceous filters, and vice versa, substances which readily passed through the plaster-of-Paris filter were held back by the siliceous filters. A series of experiments were done to answer the following questions:

1. Is filtration by the spleen mechanical in nature?
2. Does it depend upon the vitality of the pulp cells?
3. Is it electro-physical as in Berkefeld and plaster-of-Paris filters?
4. Is it selective in character?

To eliminate the mechanical factor in the process of filtration the spleen was first distended to capacity with the perfusing fluid. India ink, the particles of which are extremely small as compared with the diameter of the vascular channels and pulp spaces, was added to the perfusing fluid and was readily filtered out by adsorption to the filamentous processes of the pulp cells. Filtration was also found to be independent of the vitality of the pulp cells. Spleens were perfused first with potassium cyanide and later with the India ink solution. Filtration occurred just as readily as in the living specimen. It would seem, therefore, that the process is electro-physical in character, apparently being the same as that of Berkefeld and plaster-of-Paris filters. The question of the selective character of splenic filtration was determined by the perfusion of colloidal metals of known electrical charge. Intravenous injections of colloidal silver, platinum and copper were used for this purpose. The colloidal platinum and silver particles are negatively charged while those of copper are positively charged. It was found that the spleen quite readily filtered out the silver and platinum but the copper passed through; no trace of it could be found adherent to the pulp cells. In the case of the silver and platinum, deposits of these metals could be seen adherent to the filamentous processes of the pulp cells. It would seem, therefore, that the process of filtration by the spleen is electro-physical in character, selective, and not dependent on the vitality of the cell. Substances carrying a negative charge are adsorbed to the pulp cells.

DEVELOPMENT AND PROGRESS OF SURGERY OF THE SPLEEN *

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In MANY fields of human pathology, surgery has been privileged to play a decisive rôle, and in the diseases associated with splenic disturbances the recent era has its very basis in the study of our operative results. Most of the diseases of the spleen that are demanding surgical intervention are not as yet reproducible in animals and as a result we are called upon, after due and careful consideration, to adopt a somewhat experimental attitude in approaching many of the problems involved in this new field of therapeutic and nosological research. This newer attitude has given us a much deeper insight into the diseases of the spleen than we ever would have developed if we had followed the older non-surgical methods of approach; and as a result the advance of recent years has been by leaps and bounds compared with the thousands of years of snail-like growth in our knowledge concerning this mysterious organ.

About the physiology and the pathology of the spleen the ancients, Hippocrates and Galen, knew little or nothing, though it is interesting to recall that the former wrote of bleeding from the nose and from the gums in this connection. Galen enshrouded the whole subject in rather unintelligible mystery. He definitely disagreed with those who stated that the spleen was made for no purpose,[1] and suggested that "the residual matters from the liver"[2] are in part attracted to this organ.[3]

The following centuries added but little, so that it is not surprising that toward the end of the last century du Bois-Reymond in his lectures on physiology summed up the situation by saying, "Now, we come to the spleen. Of it we know nothing. So much for the spleen." Already at this time the spleen had been attacked by surgeons (for prolapse, hyperplasia, cysts, wandering spleen and malaria), and apparently appeared to be an organ that was not essential to life or to well-being. With the advances in hæmatology, in general pathology, and in organic chemistry, the whole picture has changed so that the recent literature is full of valuable contributions to this subject, which will surely help in clarifying our diagnostic procedures and the indi-

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[1] Galen: Natural Faculties (Loeb Classical Library) p. 143.

[2] Idem: p. 277.

[3] Idem: p. 213 et seq: Moreover, he believed that "the blood is purified both by the spleen and by the bladder, beside the liver. Also that the humours which are decidedly thick and earthy in nature and have escaped alteration in the liver are drawn by the spleen into itself thus preventing harm to the organism as a whole."

cations for therapy. In fact, Herfarth[4] collected 1,000 papers during 1916–1926 devoted to the subject under consideration, and no one interested in this subject can fail to study and to use his exhaustive and excellent review of their contents. Also, at the 1926 International Surgical Congress in Rome, the diseases and the surgery of the spleen were important topics of discussion. All of which demonstrates the vital interest taken in the study of this organ which is making for a better comprehension of its physiology and pathology.

Since Aschoff and Landau's (1913)[5] important work on the reticulo-endothelial system there has been a very strong tendency to group the spleen, anatomically and functionally, with the elements of this system, including as it does the Kupffer star-shaped cells of the liver, the medullary tissue of the bones, the lymphatic glands, and the cortex of the adrenal. All these tissues contain cells which seem to have a function related to the cells of the spleen, as suggested by their intra vitam carmin staining noted by Ribbert. It is very possible, in view of this close relationship, that after the spleen is removed the endothelial apparatus of this system takes over some of the function of the removed organ. In other cases splenules or accessory spleens are found; and these after splenectomy may enlarge, just as the remnant of the spleen after resection may enlarge and carry on the function of the spleen. In some patients these accessory spleens have been found to be quite numerous, and as many as thirty or forty scattered over the omentum have been reported by Schilling. It is interesting to note that these accessory spleens (which may be as large as walnuts) may possibly be the result of intra-uterine or post-birth injuries, because in a number of patients on whom re-operation had been done following a splenectomy for rupture of the spleen, numerous small splenic masses were found scattered, either as miliary nodules or as large as cherries, all over the peritoneal surface. Albrecht has reported finding 400 such accessory nodules.

As far as the physiology of the spleen is concerned, it has been reported by Barcroft and Stephens that this organ changes in shape during exercise, contracting to one-half or one-third its normal size. They believe the amount of blood squeezed out is equal to about one-fifth of the blood circulating through the body. A similar shrinkage of the spleen has been observed after hemorrhage, perhaps caused by release of stored erythrocytes. According to Herfarth's review, the spleen during fetal life contributes to the formation of red blood cells, and under certain conditions in adult life it re-assumes this function. In this respect there seems to be a resemblance between the activity of the bone marrow and that of the spleen, both taking part in the production of red cells and myelocytes. The spleen, moreover, seems to be the leading organ in the iron metabolism of the body; but just how this iron derived from the breaking down of the red cells is carried from the spleen and formed into

[4] Herfarth, H.: Ergebn. d. Chir. u. Orth., 1926, vol. xix.

[5] Aschoff, L: Lectures on Pathology. New York, Paul B. Hoeber, Inc., 1924.

bile pigments has not been proven, as no free hæmoglobin has been recognized in the splenic vein. It is probably tied in some way to the cells, so that it is difficult to prove its presence. Up-to-date, exogenous iron cannot be differentiated from endogenous iron, as one is liable to cover the other and no discrimination between the two seems possible. Furthermore, the spleen, like the rest of the reticulo-endothelial system, seems to be characteristically active in storing foreign coloring material, as well as body-produced coloring matters. The endothelial cells of this system have also an intimate relationship to the metabolism of lipoids.

The spleen seems to take care of the used up red blood cells, and destroy them. It also deals similarly with the blood platelets. White blood cells are also taken up in the spleen and broken down, and liberate ferments into the circulation. In the spleen, just as in the lymph glands, lymphocytes apparently are produced. In view of the fact that non-operated rats injected with pest cultures (Harris and Bullock) showed a mortality of 22 per cent., whereas of those that were splenectomized 87 per cent. died, it would seem that in some way the spleen makes for immunity against infection. It seems proven that bacterial toxins (tetanus, diphtheria), as well as intravenously injected bacteria, are taken up by the spleen and fixed there. It has similarly been claimed that immunity against tumors is probably inherent in splenic tissue, as tumor metastases to the spleen are rather rare; but the evidence along this line in experimental investigation is not convincing.

The most striking changes found in human beings after removal of the spleen, and the changes which interest the surgeon when dealing with system diseases associated with splenic disease, are the blood changes. Following splenectomy there is regularly an increase in the blood platelets, and usually an increase in the red blood cells. Moreover, in view of the fact that some of the red blood cells contain so called Jolly's bodies even as late as twenty years after splenectomy, it is suggested that the spleen may in some way influence the removal of the nucleus from the normoblasts. The blood platelets rise often to well above normal following splenectomy, as do the red blood cells. In fact, cases have been reported where the red blood cells have risen to 13,000,000. As far as white blood cells are concerned, there may be a relative increase in the lymphocytes, as well as in the eosinophile-neutrophiles. As far as resistance to bacterial infection is concerned, there does not seem to be any change following removal of the spleen. It was thought for a time that post-operative temperature and pains in the abdomen were associated with depriving the body of the function of the spleen, but although patients have been treated with splenic extract to control this condition on this basis, further study made it clear that the group of symptoms referred to were probably caused by local intraperitoneal conditions either at the ligature of the stump or in the adjacent pancreas, which may have been traumatized during operation.

During recent years, since splenectomy has become a more common procedure, a limited number of students have advocated what Weinert calls

"conservative surgery of the spleen" as opposed to splenectomy. Before the modern era there was considerable opposition to removal of the spleen, even though it had been demonstrated that life was compatible with absence of this organ. It is interesting to note in this connection that the first published operation on the spleen was along the lines suggested by Weinert, namely, ligation of the splenic vessels, by Viard in the 16th Century, who tied the vessels of a prolapsed spleen. In view of the polyglobulie, and in view of the persistence of Jolly's bodies in the red blood cells, A. Weinert [6] has again forcibly come out for less radical surgery, but up-to-date only a few have followed his line of reasoning (von Stubenrauch, Wendel and Lemaire) and have attempted to control the situation in system diseases by ligating the artery or arteries of the spleen proximal to the left gastric epiploic artery. The reason for this is in part to be found in the fact that ligation of the artery of the spleen may be more difficult than splenectomy. Still, under certain circumstances, where the spleen is very firmly adherent (as in the case reported by Lanz, where it was attached to the urinary bladder) either in an abnormal position or in its normal site, the indications for arterial ligation are self-evident. The only other operation that can be considered in most conditions is total removal of the spleen; though occasionally, in ruptures of the spleen and in localized suppurating processes or localized cystic disease, a resection or incision and drainage may be feasible. In cases of wandering spleen, splenopexy may be indicated.

The operative approach in splenectomy has varied greatly with different surgeons, and no classical incision has been generally accepted. Some surgeons have favored a vertical incision along the outer border of the left rectus; others a transverse incision; others an oblique incision from the costal margin running down toward the navel; and still others a combined vertical and transverse incision. In a few clinics, when the operator has decided upon a splenectomy an incision parallel to the left costal margin, starting over the left rectus about one inch from the free border of the ribs and running parallel to the free border of the ribs to the mid-axillary line, has been the method of choice. In case the incision has to be enlarged, the sheath of the rectus, both anteriorly and posteriorly, as well as part of the muscle, can be incised without damaging the muscle, and the incision can be prolonged posteriorly to the posterior axillary line. Although this incision apparently interferes with a number of the intercostal nerves, a weak abdominal wall after primary union is a great rarity. I understand that in Küttner's clinic this incision is popular, and most of the men at Mount Sinai Hospital use a similar approach. To give ample exposure a sandbag is placed under the left side of the chest, which allows the operator to look well up under the left dome of the diaphragm and see every step of the operation. After the abdomen has been opened and the intestinal coils have been packed off, if the hand is introduced between the spleen and the diaphragm, in simple cases where there are but few adhesions the spleen is readily delivered into the wound, so that the

[6] Weinert, A.: Zentralbl. f. Chir., Dec. 3, 1927, p. 3076.

short vessels running from the greater curvature of the stomach, as well as the splenic artery and vein, can readily be handled. It is wise, after delivering the organ well into the incision, to place a hot moist pad in the space behind the spleen while the ligation of the vasa brevia is being carried out. It is well to tie these doubly, and cut between before attempting to isolate the larger vessels of the pedicle, which are readily seen and felt through the peritoneal layer which covers them. As one is liable to draw up the tail of the pancreas in this manipulation, one should be careful in ligating the vessels at the hilus, lest one injure the pancreas. It has been my custom to ligate these vessels separately with firm chromic gut, pushing the tail of the pancreas out of the way, as it almost regularly appears drawn up by the vessels which in part run behind the tail of this organ. These vessels can be tied doubly and cut between; or, the proximal ligature being applied, a distal clamp can be used at the splenic hilus. It is somewhat risky to apply a broad pedicle clamp to this pedicle, as one is liable to damage the tail of the pancreas in this way. If adhesions to the diaphragm are found, occasionally they may be reached and tied; at other times one has to pass hæmostatic sutures over these bleeding points to control the bleeding after the spleen is out of the body. Some operators have encountered very large veins in this region, and have recommended approaching these vessels from above the diaphragm. The wound in the abdominal wall should be carefully closed without drainage, as drainage not only weakens the wall but predisposes in some cases to the development of subphrenic suppuration.

At times when the diagnosis is doubtful, as in rupture of the spleen, one may be forced to make two incisions in the abdomen, in case one cannot deliver the spleen through the original median or rectus muscle exploratory incision. A non-complicated splenectomy, under these circumstances, can frequently be done through either one of these incisions. In case the spleen is not badly torn it may be possible to suture the organ, underpinning the chromic sutures with fat, muscle or fascia so that they do not cut through the tissue of the organ. In those cases where the splenic artery is to be tied, one must look for this vessel along the upper border of the pancreas after going through the gastrocolic omentum, and ligatures can be applied to the artery as it runs along the upper border of the pancreas or just behind this organ. In the few cases where an attempt has been made to re-attach a wandering spleen, it has been recommended that a pouch be made between the peritoneum and the musculature, so that the lower pole of the spleen can be dislocated into and held in this pouch. Many of these cases, however, do not demand conservation, as the organ is frequently diseased. Even in these cases splenectomy has more often been done than splenopexy. Pre-operative and post-operative transfusions may be of invaluable service in all these operations.

In the report which I made at the International Surgical Congress in Rome, in 1926, of the work done by the staff of the Mount Sinai Hospital along these lines between 1908 and 1926, I was able to report, with Dr. N.

Rosenthal's coöperation, a series of ninety splenectomies [7] for a great variety of conditions. As many of these cases were operated upon when the indications for surgical procedures were less clear than they are at present, the mortality was unnecessarily high, twenty-eight of the ninety patients dying as a result of the surgical procedure. With more careful selection of cases as years have passed, the mortality has dropped very materially; but even at that time, in a series of fifteen splenectomies for chronic purpura hemorrhagica there were no deaths. During the last two years numerous further splenectomies have been done, with a very moderate mortality.

Instead of dealing with all types of splenic disease in this brief review, it might be advisable to limit myself to a discussion of the more common conditions for which surgery of the spleen has been employed, such as rupture of the spleen, pernicious anemia, purpura hemorrhagica, Gaucher's disease, Banti's disease, and hæmolytic icterus, as these groups illustrate most vividly the progress being made in this field of surgery.

Rupture of the spleen may involve a normal spleen or a diseased organ, and may be traumatic or spontaneous. In traumatic rupture of the normal spleen the bleeding may be so profuse that immediate operation is demanded, and splenectomy becomes a life-saving procedure. On the other hand, in some of these cases the rupture does not lead to such serious results, possibly because the capsule of the spleen is not torn, and after injury a period of well-being follows and secondarily, within a week or so, the capsule of the spleen ruptures and a serious hemorrhage occurs. These cases, sometimes called rup-

[7]	Total	Well	Im-proved	Unim-proved	P.O. Exitus	Late Exitus
Floating or ectopic spleen	1	1				
Rupture of spleen	13	11			2	
Tumors of spleen:						
a. Simple cyst	1	1				
b. Echinococcus cyst	2				2	
c. Sarcoma	3				3	
d. Lymphadenosis	2			1	1	
e. Metastatic carcinoma	1				1	
Inflammatory splenitis:						
a. Tuberculosis	1					1
b. Syphilis	1				1	
c. Abscess	2	1	1			
Gaucher's disease	5		2		3	
Banti's disease	20	12	1	2	4	1
Hæmolytic icterus	8	5	1		2	
Purpura hemorrhagica:						
a. Chronic	15	15				
b. Acute	2				2	
c. Aplastic anemia	3		1		1	1
Pernicious anemia	5			1	3	1
Leukemia	3				2	1
Cirrhosis of liver with splenomegaly	2				1	1
	90	46	6	4	28	6

ture in two stages, are often particularly puzzling to the physician. Cases have been reported where patients have had such an incomplete rupture of the spleen and have become exsanguinated from bleeding out of one of the adjacent viscera, rather than from the spleen. Naturally, exploratory operation is indicated in all of these suspected rupture cases. Recently J. Rhame reported a patient who apparently had a spontaneous rupture of the spleen immediately following his meal. There was no disease of the organ except a recent thrombosis of the veins within the spleen and a certain amount of arteriosclerosis.

Spontaneous and traumatic ruptures of the spleen when the organ is diseased are much more common in tropical countries, where malarial spleens exist, than in our community, though a few cases of spontaneous rupture have been cited during typhoid fever, as in the case reported by Downes. The large spleens of malaria are liable to rupture from slight trauma; and in some countries where malaria is prevalent, as in India and Italy, I understand that it is a criminal offense to strike a man over this region, in view of the danger of rupturing the spleen as a result of an apparently insignificant blow. With the increase in automobile accidents, it is very likely that in coming years we will see an increased number of ruptures of both healthy and diseased spleens, judging from the experience in New York City. If the operation of splenectomy is performed early, the chance of saving life seems to be very good, and in a few cases a suture of the rent may be possible.

Pernicious Anemia.—For a number of years medical men and surgeons have been flirting with splenectomy in pernicious anemia, though the results have been far from satisfactory. As the clinical course of this disease seems to vary greatly, and as many patients have remissions, it has been difficult to estimate what splenectomy has accomplished. Krumbhaar[8] collected 153 splenectomies for pernicious anemia with a mortality of 20 per cent. Of these ninety-nine were apparently benefited. But six months after the operation only fifty-three remained in this group; and after one year only twenty-seven. At the end of two years there were only two survivors, and both of these were still suffering with pernicious anemia. Fortunately, with the advent of the diet suggested by Minot these patients will in future probably be regularly spared this operative procedure.

Purpura Hemorrhagica.—Since 1916, this disease has become much better known, and many cases of the chronic as well as the acute type have been referred to the surgeon for splenectomy. The results have been so satisfactory in the chronic cases that the cure of this disease may be considered one of the triumphs of modern splenic surgery. From a review of the literature together with over twenty cases operated upon at Mount Sinai Hospital, I find that many more than 100 patients have been cured by this procedure. Under the impression that the enlarged spleen destroyed blood platelets (which, as is well known, are very much diminished in this disease) Kaznelson, a medical student in Prague, suggested splenectomy. The picture presented by this

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[8] Patel, N. M.: VII Congress of International Surgery, 1926, vol. i, p. 287.

celebrated case, which was operated upon by Professor Schloffer of Prague, is so striking that it is worth while calling to your attention briefly.

The patient presented the clinical picture of extreme thrombocytopenic purpura. She was a female of thirty-six and had been under observation for many years for chronic recurring hemorrhages. She had severe epistaxis, petechiæ in the skin, ecchymoses, and had since youth the bleeding tendency. Ten years before the operation she had had severe bleeding from her genitalia, from her nose, from her gums, and general petechiæ. Her hæmoglobin had been as low as 10 per cent., and there was a sudden crisis with improvement, but the epistaxis and petechiæ frequently developed. In 1910, she had severe bleeding after parturition and thereafter had repeated attacks of severe menorrhagia. In 1913, the tendency to bleeding still persisted, and in 1916, the year of admission and operation, there was an uncontrollable epistaxis which dominated the picture. On physical examination her spleen was three fingers' breadth below the ribs, her blood pressure was practically normal, no lymphatic enlargement, no tenderness of the sternum or tibia. Her blood examination showed red blood cells 3,792,000, white blood cells 6710, and the platelets, which were almost exclusively giant forms, numbered 200. Coagulation began in three minutes but there was no clot reaction even at forty-eight hours. The patient's nose was packed for six weeks before the bleeding could be controlled. Petechiæ developed all the time under observation and there was bleeding from the gums. After removal of the spleen, which was a comparatively simple procedure, the change in the clinical picture was most astounding. The bleeding tendency stopped. The platelets rose to 500,000, the bleeding time was shortened, the patient prior to the splenectomy used to bleed from the slightest needle prick, whereas now there was difficulty in getting a specimen on pricking the finger. Moreover, the clot reacted normally. The patient was reported, four weeks after operation, as showing a marked improvement, if not a cure, by splenectomy, of essential purpura hemorrhagica or Werlhof's disease.

The characteristics of this disease, originally described by Werlhof, now usually called thrombocytopenic purpura, are well known; and the remarkable improvement in the picture presented by these patients following splenectomy has probably been noted by every one in this audience. In a recent paper by Dr. Nathan Rosenthal[9] he calls attention to varieties of purpura associated with thrombocytopenia. The symptomatic thrombocytopenic purpuras associated with leukemia, endocarditis, splenomegaly, Banti's disease, Gaucher's disease, hæmolytic icterus, pernicious anemia, tuberculosis, etc., should naturally be excluded in the diagnosis of essential thrombocytopenic purpuras. In this paper Doctor Rosenthal refers to twenty-two cases of the chronic type cured by splenectomy, and seven more than were included in the above tabulation which was presented at the International Congress. In acute thrombocytopenic purpura operative results are far from satisfactory, as most of the patients succumb.[10, 11, 11a] Some of these cases may pass into the chronic stage

[9] Rosenthal, Nathan: Journal of Laboratory and Clinical Medicine, January, 1928.

[10] Beer, Edwin: Essential Thrombocytopenic Purpura-Purpura Hemorrhagica and Its Treatment by Splenectomy, ANNALS OF SURGERY, October, 1926, vol. lxxxiv, p. 549.

[11] Engel, D.: Arch. f. klin. Chir., 1924, vol. cxxix, p. 563.

[11a] Anschütz: Zentralbl. f. Chir., March 31, 1928, p. 810. Anschütz questions the validity of his assistant, Engel's conclusion as to the inadvisability of splenectomizing the acute cases, as apparently what Engel had interpreted as a primary bone marrow disease was subsequently demonstrated by Schulz to be an artefact. Furthermore, Anschütz states that in two peracute cases in the Kiel Clinic, splenectomy led to cure.

and others may spontaneously get well (N. Rosenthal) while others progress steadily down hill responding but little to therapy.

The theory which underlay the original operation of Kaznelson (just described) was that the spleen destroyed the blood platelets and was responsible for their very low number in the circulating medium. Frank, on the other hand, thought that while the spleen was in, it exerted an inhibition on the mother cells of the platelets, the so-called megakaryocytes in the bone marrow. Brill and Rosenthal, as well as Weinert, thought there might be an influence exerted upon the capillary vessels by disturbed splenic action, perhaps associated with qualitatively changed platelets. In the recent publication of Rosenthal just referred to he states that he believes that both the Kaznelson and the Frank factors may play a part in these cases. He believes that in those cases where the platelets after splenectomy temporarily increase in number and then drop to low levels again, the condition is due to defective marrow activity (Frank); whereas in those cases where the platelets maintain their increase following splenectomy, the spleen acts as the lytic agent (Kaznelson).

It is interesting that even after splenectomy moderate bleedings occur, or recur, but never to the extent that obtained prior to the operation, despite the fact that only a part of the reticulo-endothelial system has been removed. This paradox awaits adequate explanation.

In this group of cases X-ray of the spleen, with the hope of shortening the coagulation time, has been tried without much result. Stephan and others have become quite enthusiastic about the use of X-ray for this purpose, and they advocated it at the recent International Congress as a pre-operative procedure in all patients liable to have complicated operations associated with excessive bleeding. Apparently this has not proven to be a specific action of the Röntgen-rays on the spleen, because others have reported a similar shortening of the coagulation time after exposure of the splenic area following splenectomy. Perhaps when the coagulation time is diminished it may be due to action on the blood itself. In gynecology, the whole question in cases of menstrual bleeding is being studied on the basis of the hematological situation underlying thrombocyptopenia; and it is expected that in view of the fact that this disease is more common in females than in males, these studies will throw light on some of the abnormal menstrual bleedings. It is in this group, these purpura hemorrhagica cases, that authors such as Weinert have recommended ligation of the splenic artery; and good results have been reported following this substitute for splenectomy by at least three writers (von Stubenrauch Wendel and Lemaire).

Gaucher's Disease.—In this disease splenectomy should probably not be performed. I suppose if the diagnosis could regularly be made there would be fewer attempts to perform splenectomy in this disease. E. P. Bernstein [12] was able to make a pre-operative diagnosis of this condition by aspiration of

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[12] Bernstein, E. P.: Journal of American Medical Association, 1915, vol. lxiv, p. 1907.

the characteristic splenic tissue. In view of the fact that these aspirations[12a] are occasionally followed by serious hemorrhages, the surgeon has been hesitant in taking such diagnostic steps. Apparently Gaucher's disease is a system disease, and removal of the spleen eliminates only one element, the rest of the reticulo-endothelial system being in the same condition, or in a similar condition, to that of the spleen. Whether this is a metabolic disturbance, as suggested by Aschoff, or whether this is a system proliferation approaching neoplasia, has not been settled; but in view of the fact that the spleen is only a part of the disease, the operation of splenectomy seems of questionable propriety. In the last case operated upon by me, the spleen was removed under the impression that we were dealing with Banti's disease, and the gross and microscopic appearance was that of Gaucher's disease. Though the patient recovered and is greatly improved in general health, having gained many pounds, it is questionable whether any permanent relief has been obtained.

Banti's disease, or chronic splenic anemia, is still one of the moot questions both in nosology and therapy. Although many people believe that such an entity as Banti's disease exists, a primary splenomegaly with secondary cirrhosis of the liver developing into a third stage with ascites, others are very skeptical concerning its clinical entity. Whether the more refined blood examinations recently published by Rosenthal are going to help in the establishment of the clinical picture of this disease, as well as the prognosis following splenectomy, remains to be seen.[13] That there is a clinical picture of enlarged spleen which shows Banti's disease (originally described as "fibro-adenie") associated with leukopenia and anemia and clinically manifesting itself in hemorrhages from the alimentary tract, and going on to a cirrhosis of the liver with ascites, cannot be denied. Whether this is a primary disease of the spleen which secondarily affects the liver, is difficult to demonstrate.

Judging from the literature, typical cases of Banti's disease are more common in Italy than in the more northern climes. Splenectomy, in this group of cases, seems to have a very definite beneficial effect, even though all the manifestations of the disease are not permanently eliminated. Hemorrhages from the alimentary tract (even fatal ones) occur months or years after splenectomy. Lecene[14] only recently reported such a case in which a fatal gastric hemorrhage occurred six months after splenectomy; and one case which I presented before the New York Surgical Society[15] had a very severe gastro-intestinal hemorrhage several years after removal of the spleen in the ascitic stage of this disease. At the International Surgical Congress, Schoemaker made what is perhaps an important contribution to this subject of obscure hemorrhage from the bowel, when he reported successful control

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[12a] Diagnostic aspirations of the bone marrow have also proved of great diagnostic value.

[13] Rosenthal, Nathan: Studies on Banti's Disease. Blood Platelet Factor With Reference to Splenectomy. Jour. Am. Med. Assn., 1925, vol. lxxxiv, p. 1887.

[14] Lecene, P.: Zentralbl. f. Chir., 1928, p. 38.

[15] Beer, Edwin: Banti's Disease. ANNALS OF SURGERY, 1920, vol. lxxi, p. 216.

of some of these severe hemorrhages by splenectomy where other procedures such as resection of the bowel, or of the colon, or of the colon-cæcum, had been of no avail, the removed intestine and other examinations of the alimentary tract having been negative.

In reviewing the results of splenectomy in his disease some years ago, Banti claimed that splenectomy cured this condition permanently provided the operation was done early, and he reported cases that remained well for fifteen years. According to Banti, the operation should be done in the first and second stages only, but cases have been reported where even in the face of ascites beneficial results have followed splenectomy. Talma's operation, done at the same time as the removal of the spleen, may deserve some slight credit for the beneficial effect.

From the careful blood studies made by Rosenthal [13] it would seem that splenectomy in Banti's syndrome gives the best results in the thrombocytopenic group. In those cases, on the other hand, where before splenectomy the platelets are normal or somewhat subnormal and rapidly "increase to enormous numbers" after operation and remain high, the results are not as satisfactory. Thromboses and hemorrhages disturb the picture.

Hæmolytic Icterus, or acholuric icterus, is another system disease in which splenectomy has gradually gained recognition, as apparently no other therapy has to date proven of value. This disease occurs in two types, the original familial type being first recognized only the beginning of this century by Minkowski, and the acquired type was first noted by Hayem. Whether the underlying condition is due to an inflammatory disturbance in the spleen or not, has never been clarified. Repeatedly cases have been described running through several generations of a family, and the clinical picture in both this type and the acquired type is very much alike. Whatever the cause of the original disturbance, the spleen seems to interfere with the normal existence of the red blood cells, and as a result the patients gradually develop a yellowish discoloration of the skin and sclera. The disease is very chronic in its course, though following exposure or other infections the icterus becomes more marked and febrile attacks develop.

The most striking symptoms, as is well known, are enlargement of the spleen, icterus, increased fragility of the red cells with anemia, the presence of urobilin and the absence of bile in the urine, and a positive indirect Vandenbergh reaction. In some patients pains simulating gallstone attacks have been noted, and others have developed, as a result of inflammatory reaction around the spleen, pains in this region as well. In the mild cases, where anemia, pain and icterus are slight, it is questionable whether such a serious procedure as splenectomy should be attempted, even though it is to date the only curative method of dealing with this disease.

The operative treatment by splenectomy has become so well recognized within the last few years that some clinics have already reported many dozens of cases, with a comparatively low mortality and excellent end-results. In a recent review of the literature, 184 cases were found in which splenectomy

had been done. It would be strange if, in view of the fact that this is a system disease, removal of only a part of the reticulo-endothelial system would be curative and that no recurrences following splenectomy were to take place. In fact, a number of authors have called attention to this possibility, and have seen cases where recurrence developed, in one patient as early as four months after splenectomy. An interesting observation made on the fragility of the red blood cells following splenectomy in these cases is that though the patients are almost regularly relieved of their symptoms (the anemia and the icterus rapidly disappearing) still the resistance of the red blood cells does not with any regularity increase to the normal.

From this review of the surgical treatment of the various diseases in this group, it is evident that surgery has contributed a great deal to the clarification of the functions of both the healthy and the diseased spleen. Even though at the present time it is difficult to accurately define the indications for splenectomy in many of these cases, and even much more difficult to determine when ligation of the splenic artery should be used instead of splenectomy, still the more carefully the cases are studied and the more completely they are reported, the sooner will the clinician be able to decide upon the value of these two procedures, and in general, upon the indications for surgical attack in these varied clinical pictures.

SURGICAL TECHNIC OF SPLENECTOMY WITH PRESENTATION OF NEW INCISION

BY ARTHUR DEAN BEVAN, M.D.

OF CHICAGO, ILL.

I HAVE for some time been making a study of the surgical anatomy and technic of the operation of splenectomy. I have done this both on patients and on very fresh postmortem material, most of it but a few hours after
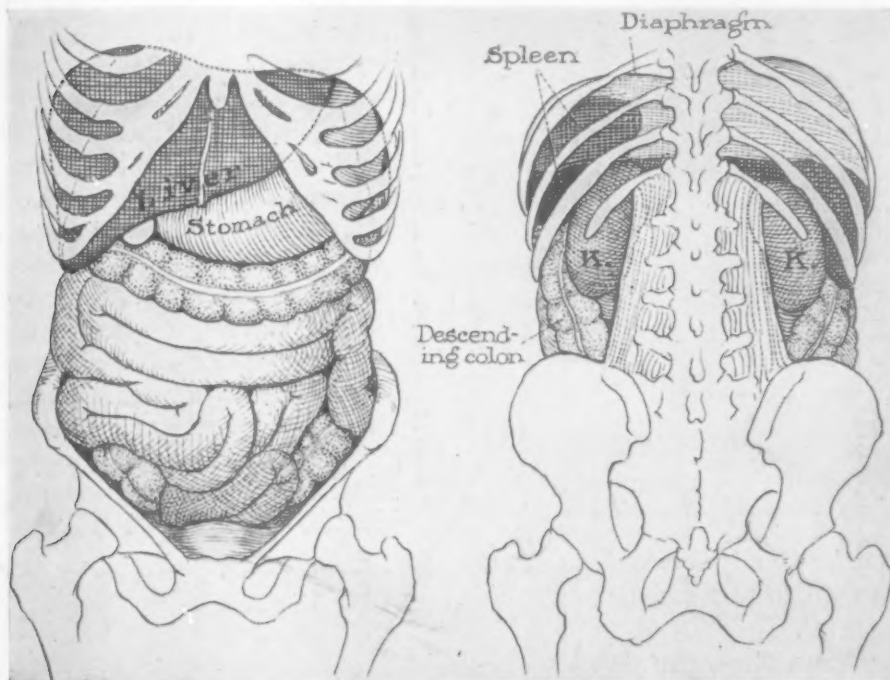
FIG. 1.—Anterior view. Spleen concealed by abdominal viscera.
FIG. 2.—Spleen covered by the tenth rib.

death, with little change in the tissues. I have found these studies have been very interesting, and they have given me a mental conception of the anatomy of the spleen under normal and pathological conditions, which has been most helpful in operative work. It is because of this fact that I have ventured to present to you briefly the results of these studies.

The spleen is normally a small organ weighing about two-hundred grams, wedged in the posterior portion of the left upper quadrant of the abdominal cavity, completely covered by ribs and completely hidden from view by the surrounding structures even when the abdomen is opened widely. This is shown in Fig. 1, a front view of the abdominal viscera. In Fig. 2, I show you the posterior view of the abdominal viscera with the posterior position of the spleen. The normal spleen extends from the lower border of

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the ninth to the lower border of the eleventh ribs, and the tenth rib covers the centre of the organ and is parallel with its long axis.

The spleen is wedged in between the diaphragm and the stomach. The organ has two surfaces, a convex surface in contact with the diaphragm, and a more or less concave surface, called the visceral surface (see Fig. 3), divided into two parts by the hilum, an anterior part in contact with the stomach and a posterior in contact with the left kidney. Just below the stomach, and beneath the vessels entering the lower part of the hilum, there is a small surface, called the pancreatic surface which is usually in contact with the end of the tail of the pancreas and below this is a broader area in contact with the colon, called the colic surface, or lower extremity of the spleen. The upper extremity is directed toward the spine. The lower extremity, or colic surface, rests upon the splenic flexure of the colon and is supported by the phrenico-colic ligament. The ante-
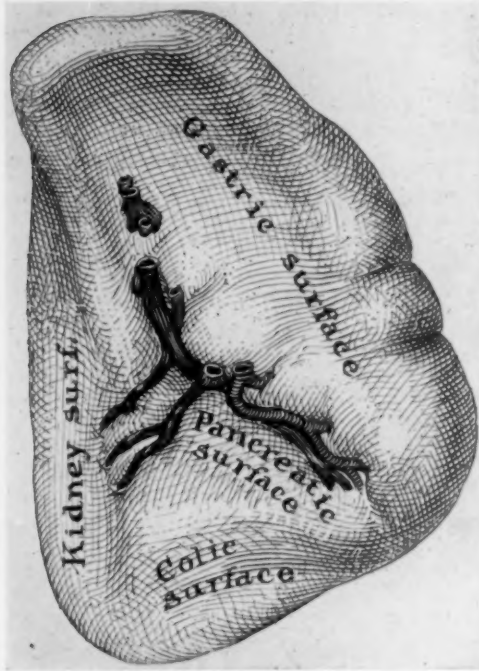
FIG. 3.—Concave surface of the spleen.

rior border is thin and notched, and the posterior rounded.

You will see that the spleen is mosaicked in between the surrounding viscera and diaphragm as a piece of mosaic in a mosaic floor, and much of its support is obtained from this fact. It is, however, supported in part by the fact that it is completely surrounded by peritoneum from which

FIG. 4.—Cross-section showing the spleen and its relations.

it receives three peritoneal ligaments which complete its support and hold it in its place in the upper abdominal cavity. These ligaments are the gastro-splenic, the phrenico-splenic and the colico-splenic. In Figure 4 the gastro-splenic and

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the phrenico-splenic ligaments are shown in cross-section. You will note that they are both formed of two layers of peritoneum; one from the greater, and one from the lesser peritoneal cavity.

In Fig. 5 is shown the posterior wall of the abdominal cavity showing roots of the mesenteric and peritoneal ligaments which invest the viscera. In the upper left area, you will note the attachment of the phrenico-colic ligament which holds the splenic flexure of the colon in position and which is prob-ably the main support of the spleen, which rests above it.

The blood supply of the spleen is entirely de-rived from the splenic artery, the largest branch of the cœliac plexus, as shown in Fig. 6. You will note that the splenic ar-tery supplies 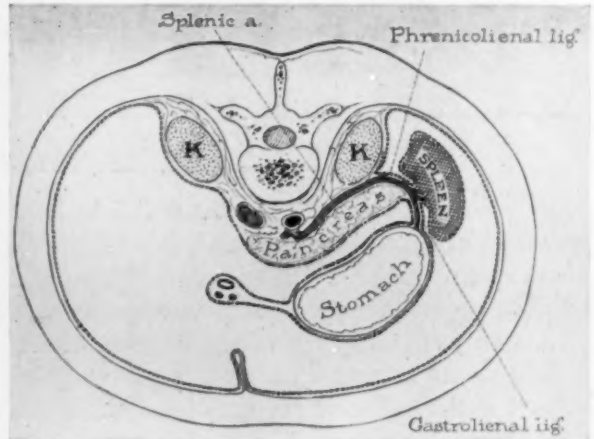branches to the pancreas and stom-ach, and then breaks up into five or six branches which enter the hilum of the spleen. You will note that the splenic artery is tortuous and the relations of the artery are such that as we free the spleen from its peritoneal attachments and rotate it toward the median line, we do not

Fig. 5.—Showing posterior abdominal wall and phrenico-colic ligament.

make any traction on its pedicle as we are all the time bringing the pedicle nearer the origin of the splenic artery. The splenic vein begins from the union of five or six veins coming out at the hilum and uniting shortly into a single large vein which is straight, not tortuous like the artery. In pathological con-ditions these veins may be very large and very thin-walled.

With this knowledge of the anatomy fully mastered, the removal of a normal spleen, as has been done in splenic anemia, is a comparatively simple matter. It resolves itself into freeing the peritoneal attachments carefully with the wet-gloved hand without tearing into the spleen pulp, rotating the spleen on its pedicle forward and inward, carrying the stomach and pancreas with it; bringing it out of the incision which may be a simple median one; and dealing with the pedicle by ligating the five or six veins and arteries in five or six separate ligatures, care, of course, being taken not to injure the tail of the pancreas. (See Fig. 7.) In pathological conditions of the spleen requiring splenectomy, there may be enlargement of the spleen, perisplenitis, or dis-

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placement of the spleen, which change the normal anatomy and require special study. Enlargement of the spleen may change the normal spleen weighing 200 grams to one weighing 2000 grams, and with this enlargement the anatomical picture is greatly altered. The 2000 gram spleen fills the entire left hypochondrium, pushes the stomach to the right, slides over the tranverse colon and splenic flexure and descending colon, and comes to occupy the greater part of the left abdomen.

The distance from the hilum to the origin of the splenic artery is short-
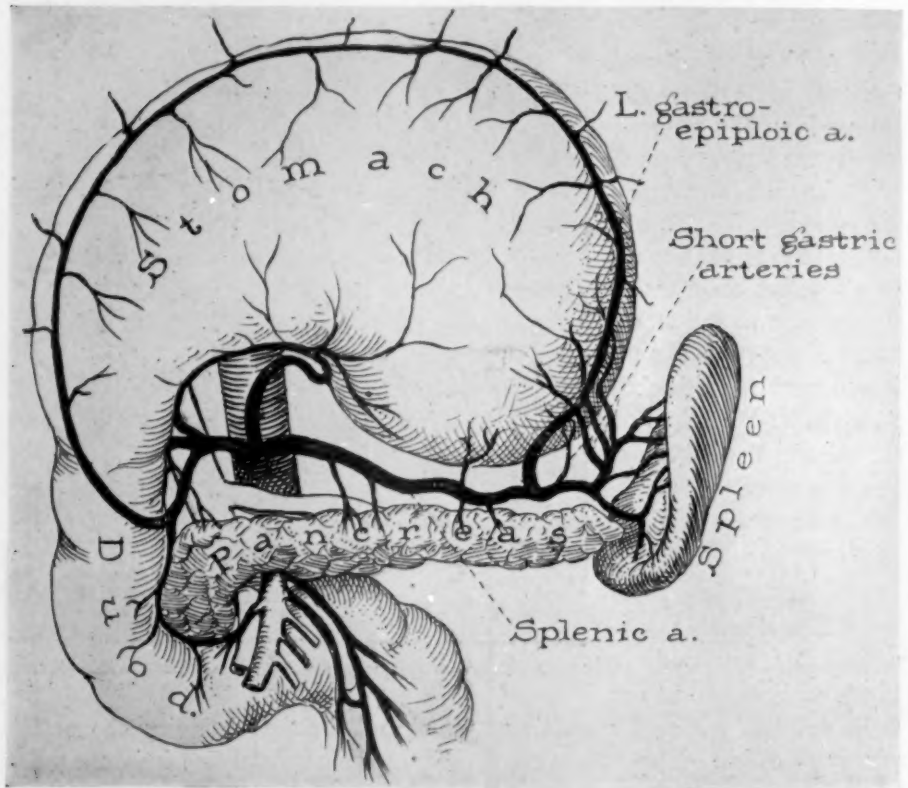
Fig. 6.—Arterial supply of spleen, stomach and pancreas.

ened; the hilum comes much nearer the median line. Splenectomy in splenomegaly, even of good size without perisplenitis and adhesions, may be with adequate incision and exposure a simple matter and mean simply careful freeing of the spleen from its peritoneal attachments, rotating the organ inward and downward and ligating separately the vessels at the hilum. Splenomegaly with perisplenitis and adhesions may furnish the operator doing a splenectomy one of the most difficult problems in surgery; here adequate exposure is essential. One cannot tell with absolute certainty before opening the abdomen whether the spleen is adherent or not; on that account, the surgeon must be prepared to handle either a simple or a difficult splenectomy. My studies have been directed to meet this situation as far as it can be met.

Many plans of incision have been suggested and carried out in the operation of splenectomy; a midline incision; an incision through the left rectus saving the nerve supply, by keeping the greater part of the muscles to the outer side of the incision, or all the muscle to the outer side as Moynihan has done; an incision parallel with the costal arch, resecting the costal arch, etc.
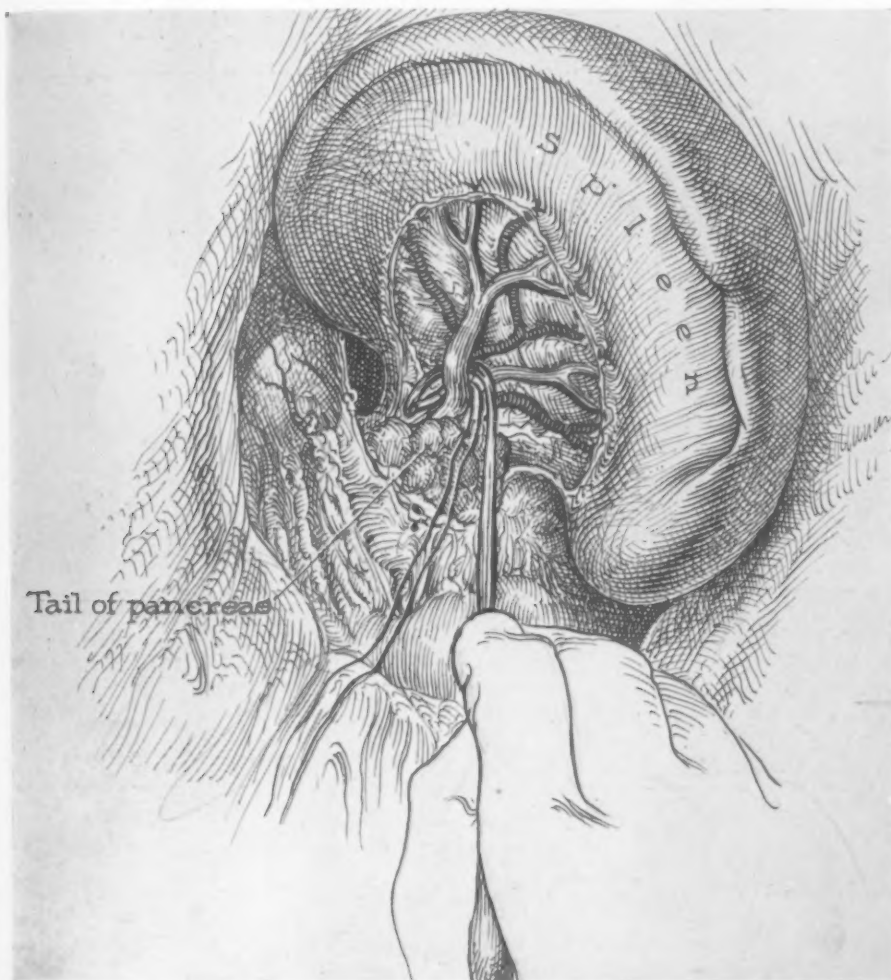
FIG. 7.—Ligating splenic vessels.

For some time I used a large S-shaped incision through the left rectus, saving the nerve supply by keeping almost all the muscle to the outer side, making the incision of sufficient length, as a rule extending it downward almost to the lower end of the enlarged spleen, and then, if extensive adhesions or other conditions demanded, curved the incision three or more inches outward dividing the rectus so that a huge flap could be turned upward and outward exposing the spleen and all the structures in the right upper quadrant of the abdomen, even the entire left half of the diaphragm. (See 1, Fig. 8.)

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This incision is a very useful one but for several years now I have simplified and improved it as a result of operative and cadaver studies. I am now using for the small splenomegalies and the simple cases a straight midline incision.

This incision begins in the left angle between the ensiform and the costal arch. It is carried downward in the midline to just above the lower border of the enlarged spleen. For the ordinary case of splenomegaly, this long midline incision will suffice.
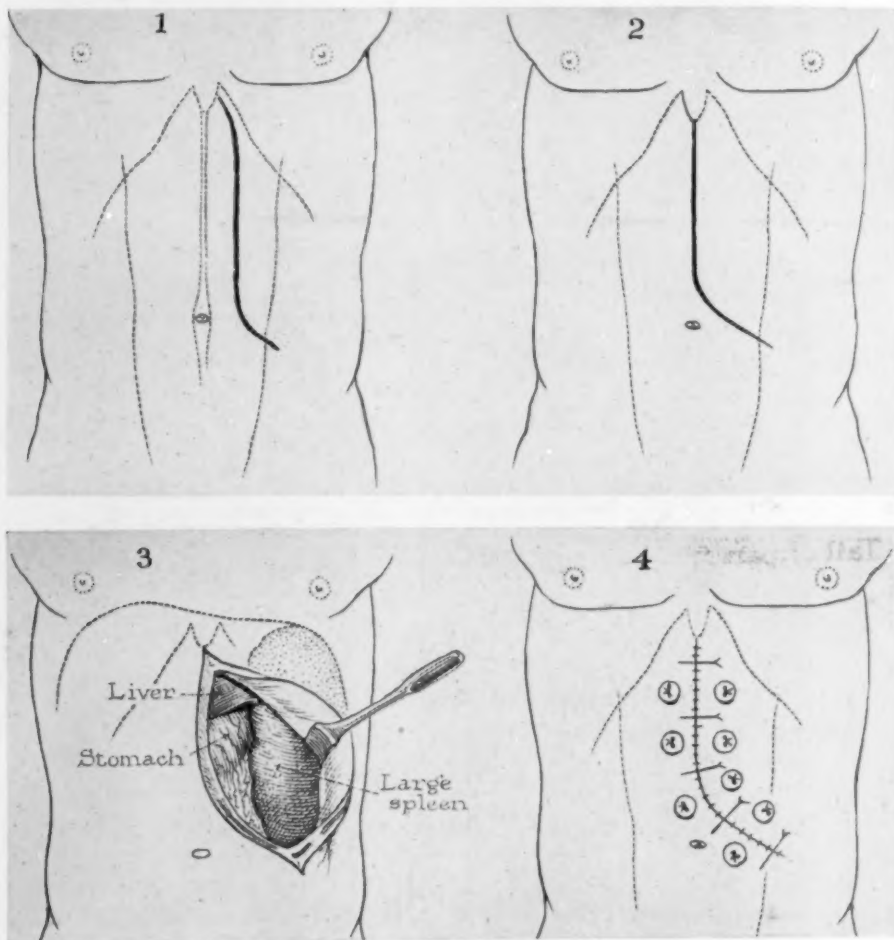
FIG. 8.

1.—Old Bevan incision. 2.—New Bevan incision.
3.—Exposure obtained. 4.—Closure.

Where because of adhesions, or other difficulties, additional room is required, the incision should be enlarged by dividing the rectus as shown in 2, 3, and 4, Fig. 8. This will give the largest possible exposure as you can demonstrate on the patient or fresh cadaver. (Figs. 10, 11.) The closure is made in the usual way with the addition of five or six sets of large button tension sutures. I have been surprised and very much gratified to find such a simple and satisfactory solution to this problem.

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These incisions carry little risk of hernia as there is no injury to the nerve supply of the abdominal wall. See Fig. 9, showing the nerve supply. They can give adequate exposure in all cases.

With the full and complete knowledge of the surgical anatomy involved the spleen can be freed from the surrounding peritoneum, usually by the sense of touch with the wet-gloved hand. If adhesions are present these can be for the most part exposed and cared for under the eye. I can see little place for the use of clamps to clamp the pedicle in splenectomy. I am quite converted to the position that ligating the vessels separately is much the safer and better way. Packing the space from which the spleen has been freed with large packs wrung out of very hot normal salt solution, as suggested by W. H. Mayo, is of distinct value; normal salt solution seems to be of greater value in producing coagulation than sterile water. Oc-

casionally a layer of peritoneum binds the spleen to the diaphragm firmly and is difficult to separate with moderate force with the gloved finger. In these cases one can leave this to the last and ligate first the pedicle proper, and then between clamps divide this peritoneal adhesion or ligament.

The wound should be closed, if possible, without drainage. If it is necessary to leave in a pack to control bleeding from a large surface, this should be removed under gas anæsthesia forty-eight to seventy-two hours later, and the wound closed completely except for a rubber tube left in down to the site from which the packing

FIG. 9.—Showing incision and the nerve supply and closure.

has been removed. If possible this tube should be shortened daily and removed entirely within a few days.

I believe that it is well worth while for anyone undertaking this work to make a careful study of the anatomy involved in splenectomy on a dozen or more perfectly fresh cadavers. The best way to secure this material is to arrange with some friendly pathologist to have the opportunity of making abdominal incisions and study the spleen for a half hour before he makes his postmortem examination. This will give you a conception of this field which will prove to be of great service to you in your operative work.

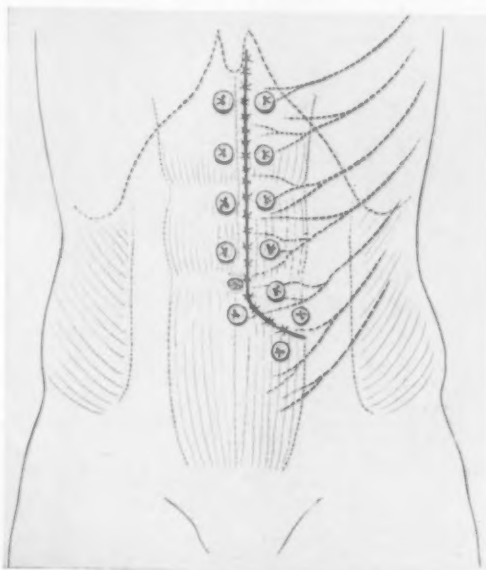I would urge a trial of the spleen incision which I have described.
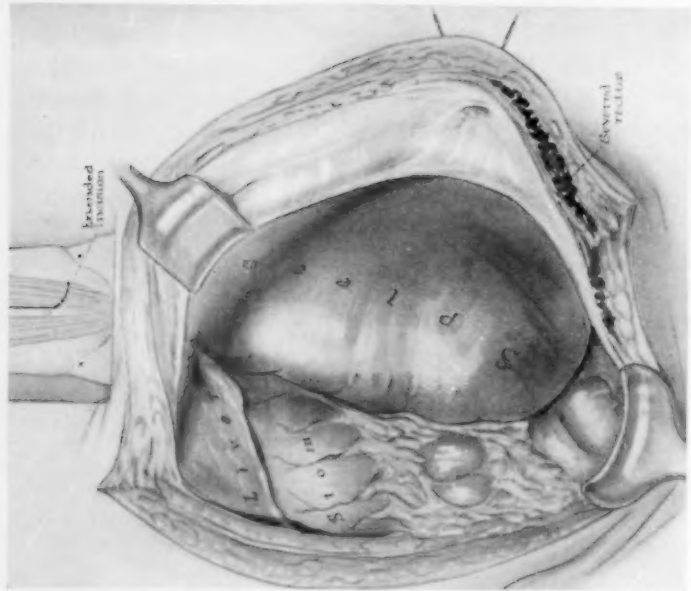
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Fig. 11.—Much greater exposure obtained by extended incision which divides the rectus muscle.
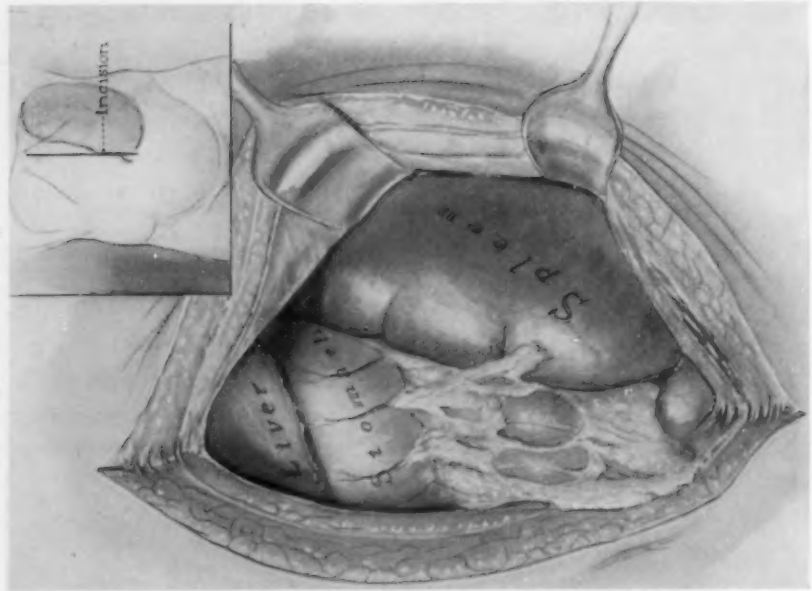

Fig. 10.—The exposure obtained by a very long midline incision.

SPLENIC ENLARGEMENT WITH CIRRHOSIS OF THE LIVER

(BANTI'S SYNDROME)

By John B. Deaver, M.D.

AND

S. P. Reimann, M.D. (By Invitation)

of Philadelphia, Pa.

Since good surgery aims to produce physiological effects for definite purposes, the results obtained will depend on the surgeon's conception of the preoperative conditions and on his idea of how he wants to change them. But with the spleen, our knowledge of the physiology is less precise than that of many other surgical conditions; our ultimate aim is—naturally, cure of the patient, but since our working knowledge of splenic diseases is limited, our conception of how we want to accomplish a cure is also limited. So we just grossly extirpate the organ and watch for results, trying to fit them to the maze of theories which surrounds the status of the function of the organ. We find but a hazy path mapped for us in the diseased spleen, and we know so little of what occurs after we have removed the organ. Fortunately, however, there are a number of beacon lights which point the way for our surgery, empiric though it is at present. In Banti's disease, we know by experience that well-selected cases are cured by splenectomy, but unfortunately, selection of the proper case is not subject to any very definite criterion, except that the spleen must be removed early, before changes, which we are pleased to call secondary, have occurred. And yet splenectomy sometimes proves beneficial in late cases. Much to our surprise, the following patient recovered extraordinarily well: Man fifty-two, three years previously had hæmatemesis and melena, mild pain in upper abdomen; treated for a year for peptic ulcer, at which time enlarged spleen and moderate anemia were noted. On admission, his spleen reached to the symphysis, was quite hard, and more or less fixed; liver also enlarged, edge palpable, very hard, considerable ascites. He was tapped once, and ten litres of fluid removed from the abdominal cavity. Blood count showed 60 hæmoglobin, 2,500,000 red cells. He vomited small amounts of blood several times. General appearance cachectic. Splenectomy performed after transfusion and followed by transfusion. Patient was tapped five times during a period of eight months after the operation, smaller amounts being obtained at each tapping until merely a quart was obtained at the last tapping. Hæmoglobin one year after operation, 80 per cent., 4,250,000 reds, white cell count normal. Strength below par, but very much increased. Apparently splenectomy has prolonged his life; undoubtedly it increased his usefulness. And yet this was a late case. It is seldom easy to distinguish a primary from a secondary splenomegaly, especially clinically, not a little because one of the ways we use to say that the spleen is the "primary" source

of the trouble, is to discover that a cure results when the spleen is removed. So let us examine our experience to see how accurately we can tell when the spleen should be removed, at least to a degree sufficient to satisfy our present practical needs.

But first, let us consider some of the ideas concerning the function of the spleen. It is not an organ necessary to life, for it can be removed and the patient continues to live in quite comfortable health, qualified, however, by the statement that its presence or absence may make considerable difference when certain emergencies arise. For example, in certain animals, at least, the spleen contains so large an amount of blood, apparently so well "sheltered" from transient deleterious influences, that if the animal is quickly poisoned with carbon monoxide gas, enough blood can be sent into the general circulation from the spleen to spare the life of the animal. Animals which have been splenectomized have no such reservoir of good blood to tide them over the emergency. Probably other demands, more physiological, are made upon this organ from time to time. It can produce red blood-cells in adults as a resumption of a fetal function, when demands are made. The part played by the spleen in the destruction of worn out blood cells is quite important. The exact mechanism is still under consideration, but according to good evidence, many red blood-cells are destroyed in the circulating blood, being prepared for destruction in the spleen perhaps, and then their products are phagocytosed in the spleen. It stores iron against future needs; it has to do with the transformation of hæmatoidin from broken down hæmoglobin into bilirubin. It has something to do with antibody formation; possibly it helps in resistance to certain infections; it surely has more resistance to secondary tumor growth than most other organs. The less said about its relation to metabolism the better, since authorities are in utter disagreement. Its relation to the lymph-nodes, the bone marrow and the whole reticulo-endothelial apparatus is shown by the behavior of those structures after splenectomy.

To sum up, just as we may, for purposes of convenience, divide diseases of the spleen into primary and secondary ones, so we might divide its functions into primary and secondary ones, that is, we may consider primary, those functions which the spleen itself has, and those secondary, which the spleen shares very intimately with other organs, specifically, the lymph-nodes, the bone marrow and the reticulo-endothelial apparatus. We might consider its reservoir function a primary one, since, when the spleen is removed, this is gone. We might also consider its contributions to the liver by way of the splenic vein, a primary function, since, when splenectomy is performed, while some of this function is taken over, no doubt, by the remainder of the reticulo-endothelial system, the latter nevertheless, is not so intimately connected with the liver, which interests us in Banti's disease. And yet perhaps it is more so, since Kupffer's cells right in the liver are very important parts of the reticulo-endothelial system. Such functions as the formation of antibodies, etc., might well be called secondary, because when the spleen is removed, they are taken up so quickly by other organs.

In disease, we can quickly list conditions in which the spleen is secondarily involved, or is only one of many parts diseased. We mention the leukemias, continuing through malaria, syphilis, to enlargements due to chronic passive congestion from central, cardiac, peripheral, and portal causes. Gaucher's disease may begin in the spleen, but in our experience with three cases, removal of the spleen quite early led to no cessation of the condition, for these patients died later of general involvement of the reticulo-endothelial apparatus, one child operated at eight, dying eleven years later. This leaves us to consider the diseases apparently beginning in the spleen, exclusive of tumors, of course. What have they in common? First, the etiology is unknown; immediately the etiology is known, the condition automatically ceases to be one of them. Second, there is splenomegaly, leading to a weight seldom less than 500 gms. and seldom more than 2000 gms. There is anemia, moderate, and of the secondary type. Then the symptoms present individual peculiarities. Some patients have hemorrhages, petechial, so that a veritable purpura is produced, or larger, as melena or hæmatemesis. Some show a slight jaundice from the beginning, others show paroxysmal jaundice with biliuria, and even hæmoglobinuria. Some show rapid loss of strength and weight, others maintain good nutrition; some develop cirrhosis of the liver early and rapidly, some apparently do not develop this condition at all; others begin to develop cirrhosis after a long period of time, years perhaps, whereupon it may occur quickly or slowly; some develop ascites early, others late, or not at all. These and other symptoms make it no more probable that we are dealing with a uniform condition than that we are dealing with jaundice, which, as we all know, was at one time considered a disease *per se*. How shall we approach these puzzles? Perhaps it is better at present to consider them variations of one and the same thing as far as treatment is concerned, but as riddles, soluble in the future as far as their philosophy is concerned.

The complex first described by Banti in 1882, and bearing his name, still remains a distinct disease entity, in spite of efforts to prove it to be secondary to infection and various other conditions. With others, we consider it so much a primary disease, that where there is the least hint of a real etiology, we cease to think of it as Banti's disease, a view which will, in all probability, require modification, but one which is still useful at present. In other words, what you do know, immediately proves that what you do not know is not present.

The disease is characterized by chronicity, although some few cases run a fairly rapid course; it begins with splenomegaly from progressive indurating connective tissue proliferation, and anemia of moderate degree somewhat similar to rather severe chlorosis, a stage lasting sometimes for years. This is followed by enlargement of the liver, progressing through a year to eighteen months, with or without mild icterus. This is then followed by the ominous shrinking of the liver, and its secondary manifestations of ascites and other signs of Laennec's cirrhosis. Severe icterus and the hemorrhagic diathesis are not very common. The spleen attains a certain size and remains so; when liver

shrinkage begins, death occurs in approximately one year. The enlargement of the spleen, at this stage, seldom less than 1000 gms., is much greater than occurs in ordinary liver cirrhosis, in which the spleen is also enlarged. The anemia in all probability is due not so much to increased blood destruction, as to diminished blood formation; there is a lack of normoblasts, reticulated cells, etc. Probably, the best view is that some toxic or infectious, but extremely poorly defined substances, are formed in the spleen which lead to fibrosis of this organ, to inhibition of the bone marrow, and to the secondary cirrhosis of the liver. Parenthetically, the cirrhosis of the liver begins very frequently in the left lobe, and at all stages is likely to be more marked in this lobe than in the right, for anatomical reasons, such as we have described in other communications.

The diagnosis then rests, first on enlargement of the spleen for no apparent cause, in an otherwise fairly healthy individual. The examination of the blood reveals an anemia, sometimes like that of a secondary anemia, at other times resembling chlorosis. There are few, if any, normoblasts and reticulated cells. Great care must be exercised in the examination of the white cells, for aleukemic leukemias occur with enlargement of the spleen, and examination of the blood in this condition, or at the time of aleukemia may show normal numbers, and even a normal differential count, although sometimes abnormal white cells are discovered. Frequently also, in aleukemic leukemia, the tendency is for other lymphoid structures to be enlarged, whereas in Banti's disease, it is the spleen and the spleen alone. The greatest difficulty is afforded by cases of primary cirrhosis of the liver in which the spleen is enlarged, but seldom to the same extent as in primary Banti's disease, to which might be added that in true Banti's disease, when the liver is cirrhotic, the chances of cure by splenomegaly are unpromising, with exceptions, however, as noted above. Given a somewhat cirrhotic liver at operation, it is always much more fibrosed in Laennec's cirrhosis as compared to the size of the spleen, than it is in Banti's disease, except in the terminal stages. In other words, the spleen is very much larger in proportion to the damage in the liver in any case of Banti's disease. Other criteria for the differentiation of splenomegaly secondary to cirrhosis of the liver, and splenomegaly primary and occurring before cirrhosis of the liver are as follows:

The spleen in Banti's disease is tougher in consistency than in cirrhosis. Peri-splenic adhesions may or may not be present. Previous X-ray treatment may stimulate them, although this is extremely difficult to determine, because we do not know what was there, or what would have been there if X-ray treatment had not been instituted. As an example, a man twenty-eight years old was operated about six weeks ago, his only complaint being a very much enlarged spleen which made his abdomen feel heavy, and interfered with his agility as a structural steel erector. He had no anemia and no symptoms of any kind. This enlarged spleen had been noticed for two years and had been treated on three successive occasions quite intensively with the X-ray, the organ shrinking considerably the first time, the second time less and the third

time scarcely at all. He came to us four weeks after the last of his three series of X-ray treatments. He had no anemia, but a leukopenia of 2000. The white blood-cells increased to practically a normal count over a period of two weeks, the most obvious cause of the leukopenia being the X-ray treatment. At operation, his spleen was found adherent superiorly and posteriorly, but was easily delivered and removed. It weighed 2300 grams. He made a good operative recovery. What effect the X-ray had in producing the adhesions is unknown. A sclerosing phlebitis is common in Banti's disease and unusual in secondary splenomegalies. This condition makes for technical difficulties in isolating and ligating the vessels. The spleen in Banti's disease on section is a lighter red than the spleen secondary to cirrhosis of the liver, and much lighter red than that of a spleen secondary to cardiac decompensation. There is less blood present in Banti's disease than in either of the other conditions. Furthermore, it is firmer, denser, fleshier; early, the follicles perhaps are more prominent because of fibrosis around central arterioles, later, the follicles and pulp are indistinguishable because the fibrosis, as it spreads centrifugally from the centres of Malpighian follicles, is met by a fibrosis which began in the pulp. The reason for less blood is found microscopically; there is narrowing of cavernous veins and sinusoids from reticulum fibre thickening and fibrosis. The spleen in cirrhosis and other conditions will probably show dilatation of the sinusoids and endothelial hyperplasia. There is little blood pigment in the spleen of Banti's disease.

To sum up, our rationale in any case of splenomegaly is to hunt for all possible etiologies. Failing in this, we consider the case a primary splenomegaly from the criteria above discussed. We contemplate, then, the removal of the spleen. This is governed, to a certain extent, by the time of the disease, by the presence or absence, as far as can be determined, of the secondary cirrhosis of the liver, by the blood count and by the serious symptoms of bleeding. Transfusion before operation is indicated when the hæmoglobin is below 50 per cent. At all events, donors are ready for transfusion after the operation, because not only may there be considerable venous oozing from adhesions, but the enlarged spleen, weighing sometimes 2000 grams, contains a considerable amount of blood which is lost to the patient. Operation is, therefore, never done hastily and without careful prolonged study of the patient. The effects of radium or X-ray treatment in temporarily reducing the size of the tumor are sometimes utilized in order that the tumor be smaller for the operative procedure. In any event, the operation is not an easy one, both because of the patient's condition, and because of inherent technical difficulties, especially since most of the cases come to operation in an advanced stage of the disease when adhesions are sure to be present, so that the vessels in the pedicle are apt to be sclerosed, and the capsule of the organ is easily torn. Unless the spleen is enormously enlarged, the pedicle can be reached anteriorly after the stomach has been drawn well to the right and the gastro-splenic omentum has been divided. In order best to reach the vessels in the pedicle, any adhesions present should be separated and the spleno-phrenic fold

of peritoneum divided, after which the spleen is turned over and the vessels are seen. This is, however, not always a simple procedure. The adhesions are apt to be dense, and may contain large veins which must be divided, as the spleen is gradually mobilized. Venous oozing must be controlled by hot gauze packs in the splenic bed. With the gastric or under surface of the spleen thus exposed and drawn into the wound, the vessels in the pedicle are cut, great care being taken to avoid injuring the tail of the pancreas. The ligatures are applied separately to each vessel as it is identified, and the vessels cut as close as possible to the spleen. After bleeding from the pedicle has been controlled, the packs are removed, bleeding in the subphrenic space is checked and the abdominal incision closed after absolute hemostasis. No drainage is used.

In the after care, if the immediate shock and loss of blood, if present, are successfully combated, the patients usually recover from the operation quite uneventfully. Since we know of no specific cause of the disease outside of the hypothetic noxæ in the spleen which is now removed, we have no specific advice to give the patients, beyond general care and attention. It is our experience, that when the patient has come to us early without much reduction in strength, recovery after the operation is quite rapid and satisfactory, but in patients such as the first quoted, there may remain an invalidism, lasting for a long time, but, with few exceptions, an invalidism which is considerably less than was present before splenectomy. Most patients who were previously unable to work can at least work at something, a few months after operative recovery. Blood counts have been made post-operatively in all of our patients, some extending over years. Some have blood which is not quite normal, there being some little change in the morphology of the cells, or a slight anemia, or a slight leukocytosis, at least something not quite normal. This is contrasted with others with normal blood counts, and several patients splenectomized for traumatic rupture of the spleen, in whom, after a number of months, the blood count returned to normal. We have had no recent opportunity to examine a patient some time after splenectomy, to discover whether any of our patients developed the curious hyperplasia of the abdominal lymph-nodes, or developed an accessory spleen such as is described in the literature. To sum up, briefly, we feel that splenectomy, if it has not cured completely some of our patients, has at least cured a few, and has rendered all of them more useful citizens and better able to do some daily tasks.

UNCLASSIFIED TYPE OF SPLENOMEGALY IN CHILDREN

By James Morley Hitzrot, M.D.

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Enlargement of the spleen in children while not rare is not common and the various varieties bear a close resemblance to the splenomegalies found in adults.

Aballi (*Vida Nueva*, Havana, vol. xx, pp. 333–504, Dec., 1927) in 7200 children found 470 with enlarged spleens. The enlargement was due to syphilis in 170, intestinal parasites thirty, malaria thirty. Anæmias of the various types as well as hæmolytic jaundice are not common in Cuba and the cases of von Jaksch's anæmia were in most cases due to syphilis.

Among the diseases of the blood with anæmia in children, malaria, syphilis, rickets, von Jaksch's anæmia, hæmolytic icterus, the purpuras, Gaucher's disease and certain congenital differences in liver size with splenomegaly are among the more frequent forms.

During the past fourteen years, four unusual cases of splenomegaly with anæmia in children have come to splenectomy at the New York Hospital, and which have, as time has elapsed, made us question our original diagnosis. The first case Margaret M. was reported by Stillman (*American Journal of Medical Sciences*, Feb., 1917, vol. cliii, p. 18, Case 1) and by me in the same year (Published report—ANNALS OF SURGERY, May, 1918, Case 10) as a case of von Jaksch's anæmia. The other three cases have not been reported previously. All three were members of the same family. (See Diagram 1.)

The main event which has given us cause to wonder just where these cases belong in the group of splenomegalies is the result of the shower of nucleated red cells which appeared immediately after the splenectomy, and which in Case 1 has persisted for fourteen years, the nucleated red cells remaining five to one in the differential blood count up to the present.

Alvaro B. Case 2, operated on in 1920 had a similar shower of nucleated red cells with other variations in the red cell a little more marked than Case 1, but with the same persistence of the nucleated red cells for eight years. In this case the nucleated red cells have been five to eight times the nucleated white cells and are a predominant feature in the smear at present and have been so throughout.

Armando B. Case 3, operated on in 1920 (brother of Case 2) showed the same shower of nucleated red cells immediately after splenectomy and this condition persisted up to the time of his death from acute meningitis, in 1922.

Victoria B. Case 4 (sister of Cases 2 and 3), splenectomy in 1922, showed a similar shower of nucleated red cells five to eight times the white cells following splenectomy and this has persisted for six years.

All the above cases showed a few nucleated red cells previous to the operation, but the high percentage following splenectomy has struck us as a

peculiarly constant feature not present in the other cases of splenectomy in children which we have studied.

Nucleated red cells are present in anæmia in children from various causes but not in such large numbers.

Hirshfeld (*Enzykld. Klin. Med.*, Berlin, 1920) states that nucleated red cells are commonly found in the blood in von Jaksch's anæmia and rarely may

DIAGRAM I.
Bettua

Father

No family history
of similar condition.

Mother

No family history
of similar condition.

| Male Normal | Female Victoria Case IV | Male Alvaro Case II | Male Armando Case III | Male Normal |
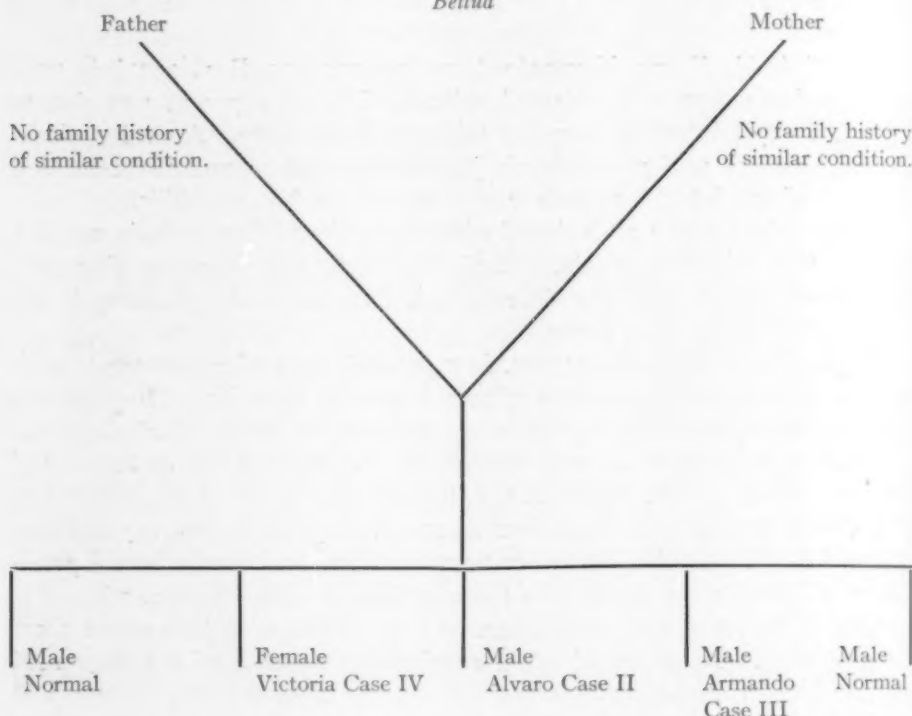
be present in as high a number as 1000 to 2000 per c.mm. In addition to normoblasts, megaloblasts are also of common occurrence.

Ostrowski (*Jahr. f. Kinderheilk*, 73, 1911) found numerous nucleated red cells in the bone marrow in cases of von Jaksch's anæmia.

Cooley, Witwer and Lee (*American Journal Diseases of Children*, vol. xxxiv, pp. 347, 363, Sept., 1927) report seven cases of splenomegaly in children with bone changes which closely resemble Case 3 in this series. They consider the type as—"a form of hæmolytic anæmia developing in early life and dependent upon some congenital defect in the hæmolytopoietic system. Clinically some resemble von Jaksch's anæmia while others resemble an atypical hæmolytic jaundice."

They give the following reasons for a definite clinical grouping:

1. Congenital cause. Hereditary syphilis is not a factor.

2. Blood picture. Striking evidence of bone marrow stimulation. An absence of increased red cell fragility. Marked nucleated red cell increase.

3. Hæmolysis. They believe the skin pigmentation is evidence of a chronic hæmolysis.

4. Bone changes. Curious striation of the long bones with thinning of the cortex as evidenced by the X-ray. Skull changes due to increased width of the diploe and thickening and striation of the outer table (Gänsslen "Turmschaedel" in the familial type of hæmolytic icterus are considered similar, *Deutsch Archiv. f. klin. Med.*, pp. 140–210, 1922.) Cooley found no similar changes in the bones in rickets, syphilis or the non-hæmolytic anæmias.

5. Peculiar facial appearance. Mongolian facies, with thick cranial bones and prominent malar bones.

Other observers (von Jaksch, Wieland, Cleve, Lehndorf, Pianese) have described nucleated red cells in the blood as a frequent feature in von Jaksch's anæmia and Hayem and the French observers have reported frequent nucleated red blood cells in hæmolytic icterus, but neither Stillman nor myself have been able to find descriptions of a blood picture which in any way simulates the enormous number of nucleated red cells (220,000 per c.mm., or higher) which have appeared after splenectomy in the cases here reported.

FIG. 1.—Tibia and fibula. Note thin cortex and cross striations in the medullary bone.

Krumbhaar (*The Spleen and Anemia*, Phila., 1918) considers Case 1 as a type of hæmatogenous icterus but in this condition, be it the acquired or the familial type, we have found no reference to a similar blood picture following splenectomy.

Another feature in all four cases is the onset of the disease in the second year with the appearance of a curious tint to the skin, bluish-white sclera, vomiting, loss of appetite and weakness. The onset was most acute in Case 3, and less marked in Cases 1 and 4, but all had a definite period at which the above symptoms predominated.

The third feature of interest was the lack of growth and development in these children. This was most marked in Case 1, who at nine years looked like a girl of three and in Case 4, who at fourteen looked about

eight years of age, and in all the cases sufficiently old to test their mental reactions these approximated the age appearance rather than that normal for their respective ages.

This arrested development was also markedly altered following splenectomy and in two of the cases (Case 1 and Case 2), after a short interval, they began to grow normally and to develop the mental traits characteristic of their real age. In Case 1 these changes were so marked that at the end of the first year the child seemed a different individual. In the girls, menstruation and puberty were both delayed, probably due to the anæmia, and in Case 4 it appeared at approximately the same period (sixteen–seventeen years) as in Case 1. The living boy, Case 2, has not yet reached puberty. Case 2 showed a number of skeletal changes, namely defects in the development of the bones of the skull, thickening of the skull with a curious striation of the outer table and thinning of the cortex and striation of the long bones (see case report) and of the teeth (X-rays). Similar changes have not appeared in the other cases.

FIG. 2 and 2a.—Skull. Note thickening of the diploe and striations in the outer table with the relative increase in thickness of the outer table.

At no time have any of these children shown any symptoms characteristic of rickets, nor have the X-ray pictures of their long bones shown any of the lesions of the epiphyses characteristic of rickets.

Syphilis as a factor in all four cases can be eliminated if a negative Wassermann is trustworthy. The parents and the children have given negative Wassermann reactions in both antigens on more than one occasion.

The question of classifying them as types of hæmatogenous icterus seemingly can be denied.

The reaction to hypotonic salt solution is but little different from normal. H_1 0.6, 0.56; H_3 0.35 to 0.25 and the resistance was increased slightly after splenectomy H_1 0.68, 0.63; H_3 0.49 to 0.25.

Urobilin was present in traces in the urine and in the blood but never in excess and there never was any trace of jaundice on the skin or on the sclera. The sclerae in fact were bluish-white and more characteristic of a high grade anæmia than of jaundice.

In the three cases in the same family the familial type of hæmatogenous

icterus seemingly can be eliminated as iso-agglutination of the red cells was not present in any of the three cases and there was no obtainable history of a familial jaundice on either the paternal or the maternal side and other children in the same family were normal.

Except in Case 1, malaria did not enter as a possible factor and in Case 1 Stillman doubts it as a factor and repeated examinations of the blood and smears of the spleen failed to show any evidence of malaria.

In none of these cases were any intestinal parasites found.

The pathological reports upon the four spleens do not help in making any definite diagnosis. Case 1 was considered as significant of von Jaksch's anæ-
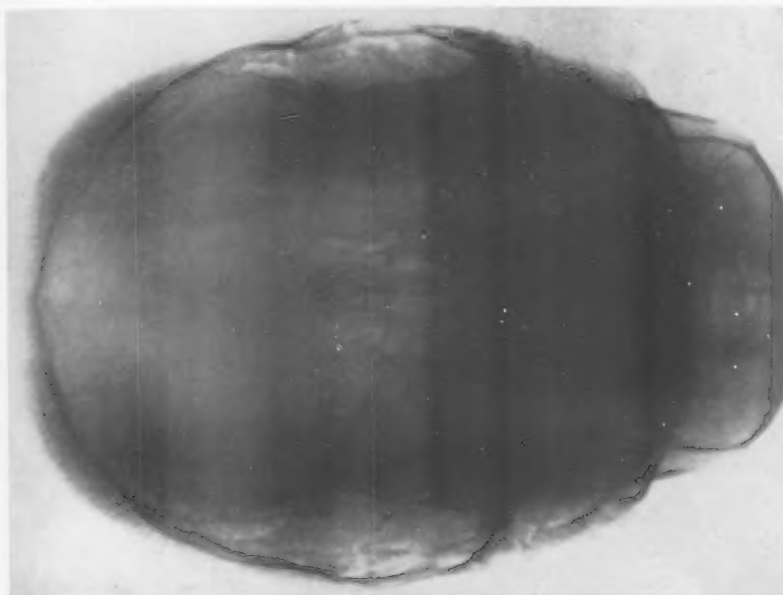
FIG. 2a.

mia by Stillman. It contained a much larger percentage of myelocytes than was found in the other cases. This was also the largest spleen, weight 1420 gms. The smallest spleen (Case 3) weighed 432 gms.

In the other spleens there was no hyperplasia of the pulp cells, the Malpighian bodies seemed normal, the capsule and the trabeculæ were not thickened. There was no evidence of myeloidization and except for a slight increase in the blood content there was nothing significant.

Doctor Elser stated that the structural changes in the spleen are relatively slight and are not characteristic of any definite clinical condition.

CASE REPORTS

CASE I.—Margaret M., age nine years, was admitted to Doctor Conner's service April 19, 1913. Family history negative. She had had measles in infancy, but gave no history of rickets; at two years of age she had an attack of malaria and since that time her spleen has been persistently large. Malarial organisms had never been demonstrated in her blood, at the time of the first attack she was living in a district in which malaria

was prevalent, and for the next six years she suffered yearly with attacks of intermittent chills and fever. Patient well nourished and developed. Heart enlarged, apical impulse tapping, and a blowing systolic murmur was heard at the apex and transmitted but a short distance into the axilla. The liver dulness extended from the fourth rib to 8 cm. below the costal margin. The splenic dulness began in the axilla at the eighth rib, and the organ almost filled the left flank, extending to 14 cm. below the costal margin and almost to the median line at the level of the umbilicus. The spleen was hard and smooth and not tender. There were large, slightly tender glands under the angle of the jaw. Weight forty-seven pounds. Eye-grounds and ears negative. Blood cultures and Wassermann negative. Von Pirquet test faintly positive. The stools constantly positive for stercobilin and negative for bilirubin and blood. The urine showed a varying output of albumin, from none up to a heavy precipitate, with occasionally a few casts. Urobilin was constantly present. The phenolsulphonephthalein output was 80 per cent. in two hours. The red cells 2,300,000, hæmoglobin 25 per cent., color index 0.5. White cells 8100, polymorphonuclears 58 per cent., lymphocytes 36 per cent., eosinophiles 1 per cent. The red cells exhibited marked poikilocytosis, anisocytosis, polychromatophilia, and basophilic granulation. There were fifty-three nucleated red cells for every 100 whites, 4300 per c.mm. A test of the resistance of the red cells showed that hæmolysis began at 0.62 per cent. NaCl, and was complete

Fig. 3.—Humerus and radius and ulna. Note conditions similar to that in Fig. 1 with more pronounced cross striations.

at 0.44 per cent. Vital staining cells made up about 35 per cent. of the total number of red cells. Repeated attempts to find malarial parasites were unsuccessful. One examination of blood serum showed no urobilin but a faint trace of bilirubin.

Her temperature varied between 100 and 102 degrees. She was given arsenic until her tolerance limit was reached, and then put upon quinin, a few doses intravenously, but most by mouth. Following the administration of the quinin her temperature fell during two days from 101 to 98 but later rose again. During her second week in the hospital she developed a dry pleurisy which was relieved by strapping. Her red cells rose gradually to 3,900,000 and hæmoglobin to 43 per cent., the index remaining at about 0.5. The nucleated red cells rose to 121 for every 100 white cells, fell to 3 and later rose again to 27, but were constantly present. Megaloblasts were found constantly. The white cells varied somewhat, but rose to 13,500 before her discharge on June 16, 1913.

She was much improved and spent the summer in the country, in the fall she complained of pains in her legs and weakness and began to lose ground. She was taken out of school, gradually became worse and was unable to get about. She was readmitted to the hospital, January 12, 1914, at which time she showed marked pallor of the skin and

mucous membranes. The heart signs were essentially the same as on former admission. The liver dulness extended from the fifth rib to 10 cm. below the costal margin. The spleen had increased in size and now extended to within two fingers breadths of the symphysis and 2 cm. across the median line. The lymph-nodes were not generally enlarged. Red cells numbered 2,400,000, hæmoglobin 25 per cent., color index 0.5. White cells were 15,000, polymorphonuclears 40 per cent. The nucleated red cells were present constantly in small numbers. Her weight was forty-seven pounds. Urine showed only a faint trace of albumin and no casts. Temperature between 100 and 103 degrees. During the next two months she received arsenic most of the time. She showed no improvement and she

Fig. 4.—Femur and pelvis. Condition similar to that in Figs. 1 and 3. Note width of rami of ischium and pubis.

was transferred to the First Surgical Division and Doctor Hitzrot did a splenectomy on March 21, 1914.

Splenectomy.—High left rectus incision, no free fluid in abdomen. Moderate amount of perisplenitis with adhesions to under surface of diaphragm, to coils of the small intestines at the lower pole, omental adhesions about hilum and anterior border. Adhesions separated by blunt dissection, the vascular ones cut between ligatures. After freeing the spleen on all sides a heavy clamp was placed on pedicle and pedicle tied, spleen removed and ligature tied a second time about the pedicle. Hæmostasis was good, some slight oozing from adhesions that had been broken up. Peritoneum closed with plain catgut, skin muscles and fascia closed in layers with through and through silkworm gut tension stitches. Several accessory spleens like medium-sized beans were left near cut end of pedicle. Hypodermoclysis was given during operation.

Following the operation she had a stormy convalescence with sharp temperature reaction, though the wound healed promptly. The day following the operation she had a marked normoblastic crisis, the nucleated red cells numbering more than 25 for each white cell. During the next six weeks she improved noticeably, the red cells rising to 4,100,000 and hæmoglobin to 40 per cent., the index remaining about 0.5. The white cells varied between 13,000 and 16,000. The nucleated red cells dropped in number rapidly

but rose again until upon her discharge on May 5, 1914, they numbered five times as many as the white cells. After leaving the hospital she continued to improve and when last seen February 6, 1916, she seemed well in every way and weighed eighty pounds. At that time the blood examination was red cells 4,600,000, hæmoglobin 65 per cent., color index 0.7, white cells 19,000, polymorphonuclears 31 per cent., nucleated red cells 138 for each 100 white cells, 2 of these being megaloblasts. The blood picture was essentially the same as upon her first admission to the hospital, except for the fact that the number of red cells and the hæmoglobin percentage were both increased.

Fɪɢ. 5.—Upper end of tibia and fibula. Condition similar to Fig. 1, but striations less pronounced.

Examination of stained blood smears after splenectomy by Doctor Stillman show an overwhelming predominance of nucleated red cells, about 28 nucleated red cells for every white cell seen. The nucleated red cells exhibit every type, there being a large number of megaloblasts and a few microblasts. The red cells as a whole are extremely irregular in shape and size, and stain very poorly. Many of the cells are very large and more or less laminated as if dragged out in the smearing and thus partly broken up. In some instances these large cells possess enormous pale hæmogenous nuclei and a few of these large nuclei are seen free on the slide. There is a moderate amount of basophilic degeneration and also a moderate amount of polychromatophilia. Many of these nucleated red cells show actively dividing nuclei. A differential count of 50 leucocytes revealed the following:

Polymorphonuclears—neutrophiles 42, basophiles 1, lymphocytes 6, myelocytes 1, nucleated reds 1420.

Pathological Report.—Splenomegaly with myeloidization (von Jaksch's anæmia).

Spleen is much enlarged but is of approximately natural shape and shows no extensive notching. Capsule is everywhere smooth and transparent. Spleen measures, after fixation in formalin, 20 cm. in length, by 13 cm. in maximum width, by 8 cm. in thickness, weight (fresh) 1420 gms. On section the cut surface bulges considerably, is of a uniform dark brown color, smooth and shining and rather firm and leathery to touch. No trabeculæ or lymph follicles can be distinguished, the color being quite uniform throughout.
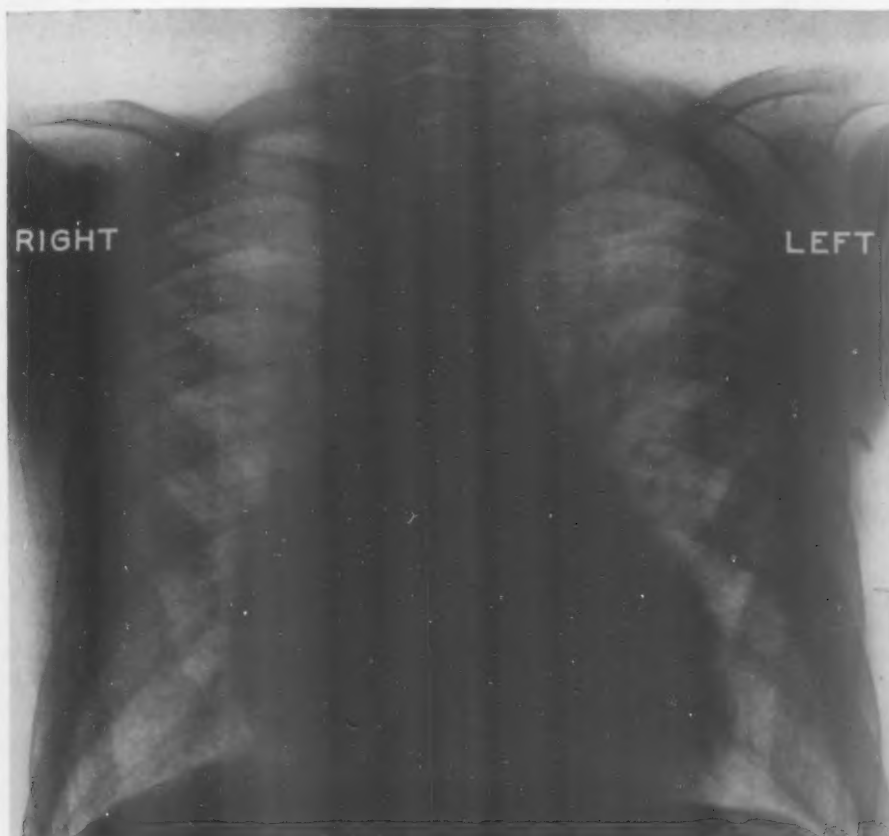
Fig. 6.—Chest. Note width of ribs and relatively large heart.

Microscopic sections show considerable congestion and considerable diffuse connective tissue increase, most extensive along the trabeculæ, around the blood-vessels, and also occurring diffusely throughout the spleen tissue. Almost no lymph tissue is recognizable, only occasional small clumps of lymphocytes being seen and no structures resembling follicles are noted. Everywhere throughout the spleen tissue there are seen numerous collections of cells, with large oval or globular, pale staining vesicular nuclei mostly containing one or two prominent nucleoli. These cells have, for the most part, a scanty, ragged, granular cytoplasm but in intimate relation to these cells there are also seen other cells which are entirely similar in appearance save that the cytoplasm is filled with eosinophilic granules. Occasional similar cells are also seen with some small collections of deeply basophilic granules. All these cells, both from their general morphology and the fact that some of them contain eosinophiles or basophilic granules, must be considered

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as myelocytes. They lie for the most part, in groups between or around the blood sinuses, but small numbers of similar cells are seen scattered among the blood cells in the sinuses. Small numbers of nucleated red blood cells are seen both with and without the sinuses. One large irregular giant cell was seen which had a deeply eosinophilic cytoplasm and five or six nuclei grouped at one end. The enlargement of the spleen and the destruction of the lymph tissue would seem to be due to the extensive production of myelocytes between the sinuses. The condition is essentially one of myeloidization and when the clinical course is taken into consideration, a diagnosis of von Jaksch's anæmia seems to be justified.

Patient has been under observation at yearly intervals. In 1925 she had a marked phlebitis of the veins of the right leg which subsided but left a little swelling. She was married in 1926 and in 1927 was delivered of a dead child at term. Following parturition she had a rather stormy time and her hæmoglobin dropped but in December, 1927, it had returned to 45 per cent. Throughout the fourteen years she has been under observation the nucleated red cells have been present in larger numbers, ranging from 45,000 to 220,000 per c.mm. Her condition is at present satisfactory and except for the anæmia and blood changes she has no physical signs that are other than normal. (See Chart, Case 1.)

CASE II.—Alvaro B., age four, was admitted to the New York Hospital (Cornell Division), March 18, 1920, with the complaint that he looked yellow and pale, was weak and did not grow.

His present illness began two years ago when he became weak, complained of pain in his left side, did not eat and vomited occasionally. His abdomen gradually became swollen. No history of fever was obtained.

His past history was essentially negative. Child was full term and normally developed at birth and quite well up to two years of age when present illness began. Since then he has been weak and sick and does not eat or grow.

Family History.—Father and mother are living and well. No history of syphilis. Two other children with same condition and two normal children.

Physical Examination.—Child is pale with a curious tint to the skin. The sclerae are "steel blue", gums pale, lips look bloodless, teeth are poor, tonsils large and pathological, heart normal in size, systolic murmur over entire precardium not transmitted to the axilla, lungs were normal—no adventitious sounds. The abdomen was protruding, no fluid wave. On the left side extending from under the costal margin to the umbilicus and down to the crest of the ilium was a large smooth non-tender mass, no notch felt, lower edge not palpable. The extremities were normal. The child looked small and poorly developed for his age. There were no evidences of bone changes significant of rickets.

Blood.—Hæmoglobin 22 (Sahli), red blood cells 2,640,000, color index 0.4, white cells 8,850, differential—polymorphonuclears 46, lymphocytes 45, large mononuclears 6, eosinophiles 1, unclassified cells which look like bone marrow cells 2, frequent normoblasts and a few megaloblasts were found and were about 10 per cent. of the nucleated cells counted. H_1 0.5, H_2 0.25, no iso-agglutination of blood, normal bleeding, and clotting time.

Blood Wassermann was negative in both antigens on April 10, 1920, and blood Wassermann of father and mother was negative in both antigens.

On April 16, 1920, Doctor Hitzrot did a splenectomy for splenomegaly.

Operation.—Four inch left rectus incision splitting the rectus muscle. There was a small quantity of clear fluid in the abdomen. The spleen was quite movable but attached behind by a well developed lieno-renal ligament. This was divided. The gastro-splenic omentum was then divided between ligatures and the pedicle of the spleen exposed. The pedicle was freed and ligated with two ligatures of heavy plain catgut, clamped on the splenic side and the spleen removed. There was one small adhesion at the

CASE I.
Margaret, Age 9.

Date	Red cells	Hæmoglobin	Color index	White cells	Differential						Resistance to hypotonic salt	Nucleated red cells	Urobilin	Wassermann	Iso-agglutination
					Polys	Eosino-philes	Lymphos	Large Monos	Unclass.	Myelo-blasts					
April, 1913..........	2,300,000	25	0.5	8,100	58	1	36	3.3	1.3	Rare.	H 0.62 H0.44	4,300		Neg.	None.
March, 1914 (before operation).....	2,110,000	33		12,000	22		75	3	12			278,000			
March, 1914 (after operation)......	2,400,000	30		14,000	20%		58%	10				126,000 Average 140,000			
Nov., 1919	4,200,000	55 (8.25 gr.)	0.65	9,500	32	1.5	44	13	1.5	9		Rare. 220,000	+urine		
Nov., 1925	4,000,000	(Dare.) 55			28.8	0.8	50.4	18.4	1.6	1.6		4.34 Rbc. to 1 white			
Nov., 1927..........	4,000,000	45%		9,700							H 64 H0.35	3 to 5 to 1 white 45,000	+urine -blood		

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upper pole of the spleen on the diaphragm but this was separated without any difficulty. After stopping the oozing, the abdomen was closed in layers using double loop silkworm tension stitches.

NOTE: Child's condition seemed about the same after the operation as it had been before.

Pathological Report.—Specimen consists of a spleen weighing 732 grams and measuring 6 x 12 x 22 cm. The capsule is not thickened and there are no adhesions visible. The color is normal. The organ is somewhat increased in consistency. The cut surface is dark red and Malpighian corpuscles are obscured. Microscopical: There is an increase in new connective tissue, not diffuse, but in strands, occurring around minute blood-vessels and as trabeculæ. The Malpighian corpuscles are not retained as such, but lymphocytes are numerous. There is an increased blood content, and a very large quantity of brownish pigment granules. Additional microscopic examination by Doctor Stillman shows reduction in the amount of lymphoid tissue due principally to reduction in the size of the follicles, many of which are poorly defined and represented by only an artery with thickened walls and a few lymphocytes surrounding it. A few follicles are normal in size though poorly differentiated from the surrounding pulp. There is an increase in connective tissue around the central artery and often an extension outward from this vessel. The pulp contains few red blood cells. The venous sinuses are compressed for the most part and there seems to be no great increase in connective tissue in the pulp. There is an appearance of hyperplasia of the pulp cells though this may be due largely to the compression of the sinuses. A few large mononuclear cells are seen in the pulp. There is no increase in the pigment content.

X-ray Examination.—X-ray examination of the skull shows it to be of a very peculiar shape and the inner table is shown as a dense line. The outer table shows the bone trabeculæ at right angles to the inner table and hair-like in appearance. The sella is very small and there is complete absence of the frontal sinus and the antra. The ethmoids are developed fairly normally. The sphenoids are very cloudy in appearance possibly due to a non-development. The skull and the jaws look very much like ape-skull. The thorax shows the cardiac shadow to be large with an unusual development of the ribs, they being very broad and heavy in appearance. The hilus shadows are accentuated and the linear markings are very definitely increased throughout both lungs.

The long bones show a marked decrease in the thickness of the cortex with curious transverse striations most marked in the lower ends of diaphysis. The condition resembles that described by Cooley.

Following the splenectomy the most striking immediate change was a marked normoblastic crisis in which the nucleated red cells rose to 102,000 per c.mm. The differential count of the nucleated cells showed:

Normoblasts	356
Megaloblasts	58
Polymorphoneutroph.	67
Lymphocytes	24
Large mononuclears	4
Bone marrow ? cells	6
Cells counted	515

This blood picture persisted throughout the two succeeding months with nucleated red cells ranging from 100,000 to 125,720.

His white cells averaged about 24,000 during this period with an average differential count of:

Polymorphonuclears 44.5
Eosinophiles 1.5
Basophiles 2.5
Mononuclears 20.5
Lymphocytes .... 22.
Marrow and unclassified cells........................... 9.

_____

100.0

His urine contained a trace of urobilin on one examination which was absent in the others.

He left the hospital in June, 1920, in good condition with an improving appetite.

His second admission was August 27, 1920, when he entered to have his tonsils removed. This was done by Doctor Farr and large pathological tonsils containing a hæmolytic streptococcus on culture were removed.

From August to December the blood picture showed little or no change from the above. On December 4, 1920, his blood picture was as follows: red blood cells 2,028,000, Hæmoglobin 32, (Sahli) 35, (Dare). White blood cells 71,400, nucleated red cells 132,600.

Differential count: Polymorphonuclears 36, lymphocytes 42, large mononuclears 16, transitionals 3, eosinophiles 2, unclassified 1. Total 100.

In February, 1921, his blood showed 220,000 nucleated red cells with a blood picture similar to that described above.

In September, 1921, he was given a transfusion of 200 c.c. of blood by the syringe method. At this time his white cells were 26,000 and the nucleated red cells 260,000 with the remainder of the blood picture about as above.

In January, 1923, he was admitted for submaxillary abscess which was opened and drained. Culture—staphylococcus aureus. Transfusion 600 c.c. (Unger method) on January 24, 1923. Blood picture before transfusion: red blood cells 2,680,000, hæmoglobin 35 (Dare), white blood cells 12,000, nucleated red cells 168,000.

Differential count: Polymorphonuclears 70, lymphocytes 28, mononuclears 2.

After transfusion, two days, red blood cells 3,200,000, hæmogoblin 45, white blood cells 14,136, nucleated red cells 126,000.

Differential count: Polymorphonuclears 39, lymphocytes 22, mononuclears 2, eosinophiles 5, unclassified 32 (myelocytes(?) myeloblasts—curious mononuclear cells disintegrating).

This condition has persisted up to the last examination in January, 1928, when Doctor Stillman reports as follows:

January 23, 1928.—Examination of a stained blood film shows the red cells to vary markedly in size, to a less extent in shape and extremely in staining. Practically all of the red cells that are not nucleated stain irregularly, not only showing pale centres but in many instances showing an irregularity of distribution as though the cell had swelled and was on the point of disintegration. Nucleated red cells, both normoblasts and megaloblasts are exceedingly numerous and are often quite highly polychromatophilic. Many of the red cells show basophilic stippling. One gains the impression that the average diameter of the red cells is somewhat less than normal. The white cells appear not to be increased though this is difficult to estimate since they make up less than twenty per cent. of the total nucleated cells. There appears to be a relative lymphocytosis but this is not certain since in all probability some of the cells counted as lymphocytes are actually erythroblasts. The differentiation between these two cells is not always easy when the staining is not exactly right. A few cells are seen which are perhaps to be considered myeloblasts though no myelocytes were found in counting 200 cells. A fair number of plasma cells were seen.

Erythroblasts number 67 plus in 50 fields with the oil objective, an average of 13½ per field.

Sixty-seven plus normoblasts and megaloblasts were counted while counting 127 white cells.

The nucleated red cells are therefore 5.3 x the white cells which are about 15 per cent. of the nucleated cells.

Differential count (200 white cells):

Polymorphoneut.	32.5%
Eosinophiles	2.0%
Basophiles	0.5%
Lymphocytes	55.5%
Plasma cells	2.0%
Large mononuclears	6.0%
Myeloblasts (?)	1.5%
	100.0%

The blood picture indicates of course tremendous stimulation of the erythroblastic tissue, apparently without corresponding activity of the leukoblastic cells. The platelets again are increased and appear so in the film. There is also apparently increased destruction of the red cells as indicated by the color of the patient and his rapid drop in red cells after transfusion, but also by the appearance of many of the cells in the film. This case is very similar to that of Margaret M. (Case 1) in its reaction and persistence of the erythroblastosis and in color.

No accepted diagnosis can be suggested.

(See Chart, Case II.)

CASE III.—Armando B., age two years and eight months, was admitted to the New York Hospital, March 18, 1920, with the complaint that he looked yellow and had a pain in his left side.

His present illness began about one year ago when mother noticed peculiar yellow tint to child's skin, attack began with vomiting two or three times daily and during the past week has had a discharge from the left ear.

Past history essentially negative, no diseases.

Family History.—Full term child, no trouble with birth, two other children in family with similar trouble (Case 2 and 4). Father and mother living and well, blood Wassermann negative for both parents.

Physical Examination.—A marasmic child, pale, sclerae blue, lips anæmic. Heart and lungs negative. Large mass extending from rib margin on left side to mid-line at navel and down almost to crest of ilium, definite notch felt, liver not palpable.

Blood Picture.—Hæmoglobin 30 per cent., red blood cells 3,328,000, white blood cells 19,300, polymorphonuclears 59, lymphocytes 33, mononuclears 8, marked changes in size and shape in red cells, a few scattered nucleated red cells found, no megaloblasts.

Fragility test:

H_1 —.6%	H_1 —.55	H_1 —.45	H —.45
H_2 —.3%	H_2 —.4	H_2 —.3	H_2—not complete at .25

Wassermann negative, stools contained urobilin. Some resistance to hemolysis of red cell, no iso-agglutination.

Anæmia increased and blood picture on April 10, 1920, shows: Hæmoglobin 18 per cent., red blood cells 2,992,000. Marked poikilocytosis, anisocytosis and polychromatophilia, individual cells pale and many different sizes, numerous normoblasts and megaloblasts.

Blood picture taken on May 5, 1920, before splenectomy shows: Red blood cells 3,528,000, white blood cells 34,594, nucleated cells 51,200, polymorphonuclears 52, lymphocytes 24, mononuclears 14, eosinophiles 4 per cent., basophiles 2, bone marrow 4 per cent.

CASE II.

Alvaro Bettua, Age 4.

Date	Red cells	Hæmoglobin	Color index	White cells	Differential						Nucleated red cells	Resistance to hypotonic salt	Urobilin	Wassermann	Iso-agglutination
					Polys	Eosinophiles	Lymphos	Large Monos	Unclass.	Myeloblasts					
March, 1920	2,640,000	Sahli. 22	0.4	8,850	46	–	45	6	–	–	Frequent	Hi 0.5 Ha 0.25	Urine Neg.	Neg.	None.
April, 1920 (after operation)	3,608,000	(Dare) 16		20,400	67	–	24	4		5	102,000	Hi 0.6 Hi 0.25	Urine +		
May, 1920				24,680	44.5	1.5	22	20.5	2.5	9	100,000		Urine Neg.		
June, 1920	2,840,000	32									125,720 (1.5% Megaloblasts)		Urine Neg.		
Nov., 1920											132,600		Blood Neg.		
Transfusion Feb., 1921															
Sept., 1921											220,000				
Jan., 1923	2,680,000	35		12,000	70	5	28	2			260,000				
Transfusion	3,200,000	45		14,136	39	–	22	2		31	168,000 126,000				
1927	3,900,000	40		6,500	49	1	47	3			124,500				
Octo., 1927											5 to 1 white				
Transfusion Jan., 1928	2,930,000	28		5,000	32	2	55.5	6	2	1.5	5.3 to 1 white				

Blood picture after splenectomy shows: Hæmoglobin 44 per cent., red blood cells 5,576,000, nucleated cells 70,400, white blood cells 18,975, nucleated red cells 51,425. About equal number of normoblasts and megaloblasts.

Blood picture June 3, 1920, shows: Hæmoglobin 35 per cent., red blood cells 3,496,000, nucleated cells 192,000, white blood cells 15.6, normoblasts 81.5, megaloblasts 2.9.

Splenectomy.—May 5, 1920 (Doctor Hitzrot), 300 c.c. of blood were given from donor by citrate method. While the blood was being transfused the operation proceeded. Four inch left rectus incision splitting the muscle. The spleen was quite freely movable and was easily delivered. After ligation of the vessels in the gastro-splenic omentum they were divided and the pedicle of the spleen exposed. The tail of the pancreas lay in the hilum of the spleen and had to be liberated before the vessels could be ligated. There were three small accessory spleens (hemo-lymph glands) on the vein about 1 cm. from the ligature. The vessels were doubly ligated and the spleen removed. The liver was normal in appearance: no pathological changes and not large. The abdomen was closed in layers without drainage, using silkworm gut tension stitches.

Pathological Report.—Specimen consists of a spleen weighing 490 grams. It is enlarged equally in all directions. The capsule is smooth and not thickened or adherent. The consistency is firm. The cut surface is dark red and the markings are indistinct. Microscopical.—The sections show a reduction in the number and size of the Malpighian corpuscles and a hyperplasia of the spleen. There are some strands of new connective tissue. Additional microscopical examination by Doctor Stillman shows reduction in the amount of lymphoid tissue due to reduction in both the size and the number of follicles. The follicles are small and poorly defined though they frequently contain germinal centres. The walls of the central arteries are not thickened. There is little increase in the amount of connective tissue. The pulp contains few red blood cells. The venous sinuses are compressed and there is a moderate amount of hyperplasia of large polygonal mononuclear cells. There is no increase in pigment content. To a certain extent the changes seen in this section resemble those seen in the spleen removed from the brother of this patient (Case 2) except that the walls of the central arteries of the follicles are not thickened, there is less lymphoid tissue, there are germinal centres present and there is much less increase of connective tissue in the pulp though more cellular hyperplasia. One gets the impression that the two spleens represent different stages of the same process.

Patient was readmitted on August 27, 1920, in about the same condition as he was upon discharge. Blood picture at this time shows: Nucleated cells 144,800, normoblasts 70 per cent., megaloblasts 12 per cent., polymorphonuclears 5 per cent., lymphocytes, etc., 13 per cent. He was sent to the country on September 3, 1920, and readmitted to the hospital November 26, 1920. Patient has had chicken-pox during the interval. Tonsils large and pathological, removed by Doctor Farr, Dec. 10, 1920. On December 22, 1920, a transfusion was given of 150 c.c.

Throughout this period nucleated red cells persisted, 86,000 per c.mm. to 120,000 and many abnormal white cells, myelocytes, megaloblasts and other irregular forms. Urobilin in urine.

Patient readmitted March 21, 1921, and a transfusion given on March 31st of 240 c.c., during this time nucleated red cells persists.

Patient readmitted October 18, 1921, and since last admission has developed into healthy looking child, has been very well until the day before admission when he had a fever and became listless. Ears have been discharging, temperature 103 degrees. Blood picture: Hæmoglobin 35 per cent., red blood cells 2,320,000, nucleated reds 80 per cent. of nucleated cells. Red cells in varying shapes and sizes and many of distorted forms.

Transfusion of 275 c.c. given on November 3rd, and patient discharged on November 9.

Readmitted on December 9, 1921.—During the interval patient's ears have discharged intermittently but he has been well otherwise and active. Two days before admission

Case III.
Armando Bettua, Age 2.

Date	Red cells	Hæmoglobin	Color index	White cells	Differential						Nucleated red cells	Resistance to hypotonic salt	Urobilin	Wassermann	Iso-agglutination
					Polys	Eosino-philes	Lymphos	Large Monos	Unclass.	Myelo-blasts					
March, 1920	3,328,000	30		19,300	59		33	8			Occasional	H. .06 H3 .03	Urine Neg.	Neg.	None.
May, 1920. After splenectomy and transfusion	5,576,000	44		18,975	52	4	24	14	2	4	51,425		Urine +		
Aug., 1920	3,496,000	35		25,000							12% Megaloblasts 118,000				
Oct., 1921	2,320,000	35									150,000				
Died Acute Meningitis.															

Case IV.
Victoria Bettua, Age 14.

Date	Red cells	Hæmoglobin	Color index	White cells	Differential						Nucleated red cells	Resistance to hypotonic salt	Urobilin	Wassermann	Iso-agglutination
					Polys	Eosino-philes	Lymphos	Large Monos	Unclass.	Myelo-blasts					
June, 1922 (before operation)	3,200,000	35		9,400	52	3	32	10	3	0	0	H1 0.64 H3 0.2	Urine Neg.	Neg.	None.
July, 1922 (after operation)	3,400,000	40		20,000	64	1	28	5	2	0	60,000		Urine Neg.	Neg.	
1923	3,856,000	45		20,000	45	6	30	15		4	23,000 35,000				
1927		50									35,000 40,000				

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patient had fever and pain in his head, was very fretful and restless. Patient was examined by Doctor Erskine, who operated for acute mastoiditis of right ear and found infected mastoid cells and antrum. (Streptococcus hemolyticus.) During convalescence patient contracted measles and was sent to Williard Parker Hospital.

Patient was readmitted on January 27, 1922, with the history that he had been perfectly well until two days before admission, when he had become acutely ill, had a high fever and vomiting. Patient had all the signs of an acute meningitis with stiff neck, Kernig's sign, etc. Child grew rapidly worse and died of meningitis three days after onset of disease and about eighteen hours after entering hospital.

CASE IV.—Victoria B., age fourteen years, was admitted to the New York Hospital, June 27, 1922, with the history that since she was two years old she had had attacks of bloating and her skin had become yellow. She has vomited at times and been quite sick, while at other times the attacks have been milder. The present attack began about four days ago and she had felt weak and tired.

Family History.—She has two brothers with a similar condition, Cases II and III. The history is unsatisfactory as it has been obtained from the girl who was in Italy with her grandparents when the trouble began. She thinks she has developed normally. Has not menstruated.

Physical Examination.—Under-sized child with yellowish tint to skin, facies normal, sclerae bluish-white, looks anæmic, heart and lungs negative. Abdomen protuberant, spleen large, smooth and hard, extends down to level of umbilicus. No tenderness over spleen, liver edge readily felt one cm. below costal margin in axillary line. Temperature ranged from 98° to 100 on day of admission.

Blood Picture.—Red blood cells 3,200,000, hæmoglobin 35, white blood cells 9,400, differential, polymorphonuclears 52, lymphocytes 32, mononuclears 6, transitionals 4, basophiles 3, eosinophiles 3. The red cells showed poikilocytosis, anisocytosis, polychromatophilia and irregularity in size.

Wassermann was negative in both antigens, urine negative for urobilin, trace of albumin, blood urea nitrogen 11.5.

Splenectomy.—July 13, 1922, (Doctor Hitzrot).—Five inch left longitudinal incision splitting the muscle. The spleen was delivered easily, the only adhesions being some between the stomach and the spleen. These adhesions were divided between ligatures. The pedicle was ligated, ligating the arteries separately and compressing the spleen before ligation of the vein. The spleen was removed and the splenic fossa peritonealized by three interrupted plain catgut stitches. The gall-bladder was a little thick but was not pathological. The liver was soft, showed no evidence of any microscopical change. The other abdominal structures were normal. The appendix was not removed. The abdomen was closed in layers without drainage with double loop silkworm tension stitches.

Pathological Report.—Specimen consists of a large spleen weighing 900 grams and measuring 20 x 12.5 x 7 cm. The spleen is uniformly enlarged and has preserved its normal shape with the exception of a rounded projection near one pole which measures 5 cm. and is elevated about 1.5 cm. above the neighboring structures. This appearance suggests the existence of a tumor-like process in the spleen. The capsule is somewhat wrinkled which suggests that a certain amount of exsanguination of the organ has occurred following its removal and that the projection of the area referred to may be occasioned by the shrinkage of the rest of the spleen without corresponding reduction in the size of the tumefied area. This further suggests that the blood in the tumor-like portion of the specimen is not fluid and so does not escape readily. The organ is grayish-blue, its capsule slightly thickened and its consistence fairly firm, somewhat leathery. Cut section presents a beefy red, finely granular surface. The stroma is not particularly prominent. Malpighian bodies are fairly numerous and slightly enlarged. In one pole of the organ, corresponding to the protuberance referred to above, there is a globular, sharply circumscribed tumor-like mass measuring 5 cm. in diameter. It appears to be surrounded by a very thin capsule and differs in structure from the remainder of the organ. It pre-

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sents a perfectly smooth surface on section and reveals little evidence of structure. It is dark red, shows no evidence of the presence of stroma or of structures resembling Malpighian bodies. It is traversed in places by a fine net-work which is dark red in color and here and there trabeculæ of very delicate connective tissue bands are noted. The vessels supplying the spleen show no gross lesions. Microscopical examination based upon the study of material fixed in formalin, Muller-formol, Zenker and bichloride and stained with hæmatoxylin-eosin, von Gieson and Mallory's aniline blue.

Sections made from the spleen proper. The Malpighian bodies for the most part appear normal though a few show some evidence of compression and a lack of sharp differentiation from the pulp and occasionally one sees some central hyaline degeneration. The walls of the central arteries are apparently not thickened. Germinal centres are present in a fair percentage of the follicles. In the pulp, the venous sinuses are slightly dilated and there is an irregular distribution of areas of congestion. There is no definite hyperplasia of pulp cells and no increase in pigment. In the pulp one finds here and there mononuclear cells with acidophilic cytoplasm, usually located within the sinuses. The nucleus is round and the cytoplasm has a finely granular appearance. These cells are probably myelocytes and are found singly, not in groups. The appearance is not that usually found in so-called myeloidization. There is no increase in the amount of phagocytes of red cells above that found in the normal spleen. The capsule and trabeculæ are not thickened. There is some increase in connective tissue in isolated areas in the pulp.

Sections made from the tumefied portion. At first glance these sections have no resemblance to normal splenic structure. There are no Malpighian bodies. The general appearance is that of small islands of cells showing very few erythrocytes surrounded by bands of tissue which is markedly congested and contains relatively few nucleated cells. On closer study there appears to be a suggestion of the presence of sinus structure or at least of channels without definite cellular walls though this may be merely an arrangement of the reticulum. The reticulum fibres are more abundant in the congested portion of the tissue and outline the cellular islands giving off to them delicate fibrils. The cells in these islands present nothing especially characteristic. They resemble splenocytes though vary greatly in size and show moderate anaplasia. Here and there are seen a few very large cells with eosinophilic cytoplasm having a slightly granular appearance and from two to eight large nuclei. There is no necrosis. The blood in the so-called congested areas has all the appearance of being stagnant and altered. This confirms the suspicion referred to above, that failure of this portion of the organ to shrink is due to lack of fluidity of the blood contained in it.

The tumefied portion of the spleen represents the results of interference with the circulation, probably due to thrombosis of a vessel. This feature, which differentiates this spleen from those removed from two other members of the same family, is without special significance. The structural changes in the spleen are relatively slight and are not characteristic of any definite clinical condition.

The child made an uneventful recovery although the temperature rose to 103 for two days after the operation. The hæmoglobin fell to 15 per cent. and a large number of normoblasts and megaloblasts appeared in the smear. She was given two transfusions of 500 c.c. each, both of which raised her hæmoglobin to 35 per cent. and 55 per cent., but in two days the hæmoglobin had fallen to 30 per cent. showing an active hemolysis of the introduced blood. This condition continued until January 18, 1923, when she was again transfused and hæmoglobin brought to 55 per cent., red blood cells 3,920,000, nucleated cells 20,150 of which 20 per cent. were nucleated red cells among which were many megaloblasts. Her last blood examinations in 1927 still showed 35,000 to 40,000 nucleated red cells although her general condition had improved and she looked better although there was still an evident anæmia (Hæmoglobin 50 per cent.).

X-ray pictures of the skull and long bones showed no gross changes although the cortex was thinner than normal in the long bones.

ATYPICAL HÆMOLYTIC ANEMIA WITH SPLENOMEGALY IN CHILDREN

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and

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In the study of the splenomegalies associated with the anemias, one is impressed with the difficulty of placing individual cases in the well-known groups or classifications. Especially is this true in those occurring in children. The one common factor in all these lesions is apparently the dysfunction of the reticulo-endothelial cells. In some, the abnormal reticulo-endothelial cells would seem to be concentrated in the spleen, for splenectomy in such lesions as typical chronic hæmolytic icterus permanently cures the disease and restores the patient to a normal state of health. In others, such as thrombopenic purpura, the dysfunction of the reticulo-endothelial cells may be limited to the spleen, but later even after splenectomy the dysfunction of these cells in other organs like the liver, lymph-nodes or bones, may reappear with fulminating hemorrhages. In still another group, the so-called Gaucher type of splenomegaly, the abnormal cells are present not only in the spleen—where they are most numerous, but are to be found in the liver, the lymph-nodes and the bone marrow.[1] The variation in the type and degree of dysfunction of the reticulo-endothelial cells may well account for the many cases of splenomegaly associated with anemia and jaundice that do not fall into the well recognized groups.

In 1925, Cooley and Lee[2] of Detroit first reported a group of five cases of splenomegaly with anemia and jaundice that differed from the hæmolytic jaundice or the Von Jaksch's anemia seen in children. In September, 1927, Cooley, Witwer and Lee[3] reported two more cases. One of these seven cases had had the spleen removed without definite improvement. In March, 1927, one of us performed a splenectomy on a child in whom the diagnosis of atypical hæmolytic jaundice had been made. Certain striking bone changes as seen in the röntgenograms, and atypical cells in the spleen resembling Gaucher cells were convincing evidence that we were dealing with an unusual variety of splenomegaly. In studying the literature we did not find any references to this type until we read Cooley's report of five cases.

Because a discussion of this type of splenic anemia or hæmolytic icterus has not appeared in the surgical literature, so far as we have been able to discover, we are presenting the case histories and findings in two sisters with these lesions on whom splenectomy has been done.

Whether these nine collected cases can be grouped as a clinical entity is open to question, but they present certain striking similarities which should arrest the attention of those dealing with splenomegalies in children. Thus

far no such cases have been observed in the adolescent or adult periods. Of these nine cases, three died of the disease and were autopsied, three have been observed under conservative therapy consisting of diet, transfusion and tonics, one with improvement for a period of thirty months. Three have had splenectomy, one without improvement nine months after operation. One of our two cases has been observed fourteen months after splenectomy with improvement as regards nutrition, anemia and growth, but with an occasional exacerbation of jaundice. The other one of our cases has not been observed for a long enough period to state the effect of splenectomy.

The following features of the disease have been noted in all nine of the known cases:

1. The onset is in infancy. Usually shortly after weaning the failure of the child to gain has attracted the mother's attention, to either the anemia, the jaundice or the enlarged abdomen.
2. All nine children have had an enlarged spleen.
3. All have had a profound anemia due to red cell destruction and the majority an appreciable but irregular acholic jaundice, without an increase in red cell fragility.
4. All have shown evidence of a striking overstimulation of the bone marrow as shown by the immature red cell forms.

Because of these factors certain striking physical signs, röntgenographic findings and laboratory data are present and help to group these cases.

1. The facies. Two points are striking. The muddy jaundiced color varying with the amount of hæmolysis and the Mongolian features, due to the thickening of the cranial bones especially the frontal, the malar and the parietal bones.
2. The röntgenograms. The films of the skull show marked thinning of the inner and outer tables with very great thickening of the diploë especially in the frontal and occipital bones. The films of the long bones show a lack of calcification except for transverse lines of calcium giving a streaky appearance.

The marked hæmolysis is evidenced by the low hæmoglobin, the low red cell count, the great excretion of urobilin in the stools and the icteric tinge of scleræ and skin.

The overstimulation of the bone marrow is shown in the hyperplasia of the cancellous bone, particularly in the diploe of the skull causing the röntgenographic picture, and in the enormous numbers of normoblasts and reticulated red cells. In none of the blood smears or in the post-mortem studies has there been evidence of leukemia. There has been a leucocytosis in several of the cases suggestive of the Von Jaksch's anemia.

As regards the bone changes seen in the röntgenograms, Cooley states that these changes are the result of the reaction of the bone marrow to prolonged overstimulation as a result of chronic hæmolysis, beginning before the cortex is strong enough to limit the overgrowth of bone marrow. In examining a number of films of these cases, there seems to be a definite pathological entity, in that these bone changes are very similar in each instance. These changes apparently begin very early. As the chronic hæmolytic process advances the marrow hyperplasia increases at the expense of the cortex which

becomes markedly thinned and decalcified. In the bones of the skull, for instance, the cortex is expanded, especially in the parietal and frontal regions. The outer table of the skull expands giving the children a Mongolian appearance. This finding seems to be fairly consistent. The long bones in these cases show this marked decalcification, marked thinning of the cortex and numerous lines of increased density. These lines generally run transversely through the shaft. We are at a loss to explain these changes which are present in the early stages of the process. It indicates a replacement of exhausted marrow by new bone but just why it should be laid down in this thin transverse layer, and in the early stages, we have not yet fully determined. In one case observed by Grulee and Cooley, the diagnosis of sickle-celled anemia was fairly well established and in this the case of above bone changes were noted. Gänsslen [4] described certain constitutional markings in cases of hæmolytic icterus but so far as we were able to determine no Röntgen studies similar to those recorded here were noted. In earlier stages and in less severe cases, the porous appearance in the röntgenograms seems to represent marrow hyperplasia, while in the terminal stages the pronounced striation indicates replacement of exhausted marrow by new bone as seen in the autopsied cases. The studies of the blood calcium and blood phosphorous in Cooley's cases and in one of our patients does not throw any definite light on the cause of the bone changes. The variations in these blood elements are not controlled by splenectomy.

The study of the spleens removed at operation or autopsy show a marked increase in the fibrous tissue of the capsule and trabeculæ. In the two spleens which we removed special stains were used which bring out more clearly the architecture and the cell structure. Dr. Stout's report is as follows:

Microscopic.—"Sections of the spleen have been stained with Masson's Ponceau, aniline blue, acid fuchsin and iron hæmatoxylin; with Masson's metanil yellow, acid fuchsin and iron hæmatoxylin and with Scharlach R. The only lesions noted are a mild degree of fibrosis which is generalized and the presence at scattered intervals in the splenic pulp of rather large cells with eccentric nucleus and with the cytoplasm vacuolated. The material in the vacuoles does not stain with Scharlach R which rules out the lipoid bodies. It stains a faint delicate blue with the aniline blue and a very pale yellow with the metanil yellow.

"The splenic corpuscles are rather widely separated and the pulp has little blood in it so that the spongy sinuses are easily made out. They contain no unusual type of blood cell. There has not been time to have the spleen analyzed to determine the presence or absence of the cerebroside kerasin, the material which is found in the large cells of Gaucher's disease. The picture in this spleen is identical with that seen in the spleen of this patient's sister (Marie). Whether these scattered cells mean a mild Gaucher's disease or not, I cannot say because I do not believe that the early lesions of the spleen in Gaucher's disease have ever been observed. I have never seen these cells with vacuoles in any other spleen except those of Gaucher's disease."

Inasmuch as sections taken from other typical chronic hæmolytic icterus spleens, and from other splenomegalies in the laboratory fail to show any such cells except in the three Gaucher spleens in our collection, the question arises as to whether these two cases are related to early Gaucher lesions. They are probably not early Gaucher cases, but the cells which resemble the Gaucher type are probably atypical or abnormal reticulo-endothelial cells. Many pathologists consider the Gaucher cell a form of abnormal reticulo-endothelial cell.

Only five-and ten-year follow-up results will determine the value of splenectomy in this group of hæmolytic anemias. We have not as yet seen any striking improvement in our two cases, comparable to splenectomy in chronic hæmolytic icterus.

CASE HISTORIES

CASE I.—A seven-year-old Italian girl was admitted to the Presbyterian Hospital, New York City, for enlarged liver, enlarged spleen and jaundice of two or three years' duration. Her family history was negative except that her sister, three years old, had been jaundiced for three or four months and had always been weak and refused her food. The brother was normal in every way.

The child had been weak since she was a year old. At birth the child weighed 8½ pounds, following a very easy labor. She was breast fed 11½ months, gaining well. Her infancy seemed quite normal in every way. At one year the child had measles. Following this she had pertussis for almost a year, which disease was complicated by a "capillary bronchitis" and an acute otitis media. Until a tonsillectomy at two years, the child had frequent sore throats. Always there had been occasional toothaches and many cavities.

When the patient was three years old she started to have attacks of jaundice for three or four days, recurring every three or four months, which would clear up with the use of cathartics and unknown medicines. In the interims her color was good.

When she was five years old, her brother was suspected of typhoid and the patient was examined at the same time. An enlarged spleen was discovered. During this period she was sick for a month and had a stiff neck and a fever as high as 105°, but no other details of her illness could be learned. About six weeks after her recovery from this acute episode, she was taken to Bellevue Hospital, New York City, where her diagnosis was recorded as familial hæmolytic jaundice. There she was noted to be acutely ill with a soft systolic murmur heard best in the third space to the left of the sternum, an easily palpable liver 3½ cm. below the costal margin, a palpable spleen, a hæmoglobin of 55 per cent. and a red blood cell count of 3,510,000. About three weeks later, the family refusing splenectomy, she was discharged against advice. At discharge, in spite of one transfusion, her hæmoglobin was 40 per cent., her red blood cell count 2,480,000.

For the ensuing two years her appetite became progressively less. Occasionally she had abdominal pain, or slight constipation. The bowel movements had not been observed. Dyspnœa was easily brought on, the patient having been carried upstairs to avoid it, and palpitation had become progressively more severe. There was no cough.

Except for nocturia once nightly and very dark urine—as dark as "coffee"—the genito-urinary symptoms were negative.

For the three weeks preceding admission she had been irritable, extremely weak and feverish, her temperature running to 103°.

Physical examination disclosed an almost moribund child of Mongolian appearance. There was noticeable dyspnœa, rapid and marked carotid pulsations and a yellowish tint to the skin. The sclerae seemed somewhat icteric. The mucous membranes of the lips and mouth and the tongue were very pallid. The heart was enlarged and presented a soft

apical systolic murmur and a soft early diastolic murmur heard well in the third and fourth spaces to the left of the sternum. The abdomen was markedly convex. The liver edge was felt at the level of the umbilicus and the spleen was about 3 cm. below the costal margin. Both kidneys were palpable.

In the hospital, the child's initial blood findings revealed a hæmoglobin of 25 per cent., a red blood count of 1,670,000, and a platelet count of 100,000 per mm.[3] Her white blood cells numbered 6,100, with 29 per cent. of polymorphonuclear neutrophils, 69 per cent. lymphocytes and 2 per cent. large mononuclears. The admission temperature was 100.6°, the pulse 130 and the respirations 32.

The blood Wassermann was negative. The clotting time was not increased, but the bleeding time was 6½ minutes as compared to one minute in the control. The fragility test was normal.

The child received eight weeks' treatment followed by splenectomy. The pre-operative therapy comprised ten transfusions of between 100 and 300 c.c. and daily doses of maltine with cod liver oil and an elixir of iron, quinine and strychnine phosphate. The hæmoglobin increased to 70 per cent. and the red blood count to 4,140,000. Clinically there was marked improvement, the girl stating she felt better than she had "since she was a tiny baby". With improvement of the anemia, the diastolic cardiac murmur disappeared and the systolic murmur diminished and was mostly heard over the base. For several weeks her maximum daily temperature ranged to about 100.5°, gradually becoming normal. Three blood cultures were negative, one showed Streptococcus Viridans. The blood calcium was 9.05 mgs./100 c.c., the blood phosphorus 5 mgs./100 c.c. A second fragility was again normal. A reticulated count showed less than 1 per cent. of these cells. Repeated blood smears were characterized by marked anisocytosis and poikilocytosis and, at first, marked acromia of the red blood cells, a few normoblasts and occasional to rather common diffuse basophilic cells. Over a period of four days, the average daily urobilin excretion in the stool was very high, namely 20,370 dilution units. On two occasions the urine contained a trace of urobilin; the foam test for bile was positive several times and negative several times. Gastric analysis was not done.

An X-ray of the lungs showed them to be clear. X-rays of the skull were featured by rather marked decalcification of all the bones, and rather marked widening of the diploë with numerous small areas of decalcification. In the films of the long bones, there was considerable decalcification of all the bones which was quite marked, leaving striated lines in places. The lower ends of the femora appeared somewhat flared out and wide for a child of this age.

Splenectomy was performed March 2, 1927, by Dr. Allen O. Whipple. At operation the liver was found enlarged and harder than normal. The spleen was about half again the size of a normal spleen, and was removed because of what was thought to be hæmolytic icterus.

Pathologically, the spleen was injected while warm with a warm neutral red solution and after half an hour sections of tissue were taken and prepared according to Gardner's technic. About two hours after this, smears were made from the scrapings of the pulp. These showed large numbers of phagocytic cells containing iron pigment. They also showed a few cells with granules of neutral red in the cytoplasm. The permanent sections failed to show any cells containing neutral red granules. Microscopically, sections from various parts of the spleen showed some increase in the number of collagen fibrils in some areas, showing there had been an irregular fibrosis. The splenic corpuscles were small and widely separated by the pulp. This showed widely dilated sinuses and venules. In view of the finding of so much phagocytic blood pigment from the fresh smear from the pulp, there was an astonishing absence of phagocytic cells with brown pigment in them in the stained sections. In some of the sinuses there were some very large mononuclear cells with a great deal of cytoplasm. In these cells. under oil immersion, were veinings with fine fibrils, reminiscent of the large cells of Gaucher's disease, but their numbers were relatively few. Inasmuch as there is no characteristic pathology of the

spleen of hæmolytic jaundice, the patient's spleen was considered as maybe well representing that disease.

The child remained in the hospital three weeks after the operation, recovering uneventfully. Two 24-hour urobilin determinations as the stool showed 10,880 and 6,400 dilution units respectively. At discharge the hæmoglobin was 70 per cent., the red blood cells 3,650,000.

Since discharge from the hospital, fourteen months ago, the patient has been active and doing well at school. Her mother states that her color has varied from day to day; some days she is very jaundiced, other days almost rosy. Two weeks ago the hæmoglobin was 47 per cent. and the red blood cells 3,400,000. Several previous blood counts, from time to time, gave approximately the same results. In the smears, there have been very numerous nucleated red blood cells. Further X-rays of the long bones have shown no change in appearance. Except for more thickening of the diploe, the skull X-rays are similar to those originally taken.

CASE II.—A three-year-old Italian child was admitted to the Presbyterian Hospital, March 12, 1928, with a chief complaint of anemia, poor appetite, and inability to gain weight almost from birth.

The father and mother were living and well, though the mother gave a history of attacks of acute gall-bladder disease about the time of the birth of the oldest child. The patient's sister presented a condition similar to the patient, and had had a splenectomy one year before, following which she had improved though still anemic, occasionally feverish and showing yellowish discoloration of the eyes. No history of familial disease was otherwise obtainable.

The child was born at full term, after a normal delivery, and weighed 10½ pounds. No icterus was seen at birth. For ten or eleven months the infant was breast fed, but received orange juice at five months but no cod-liver oil until the second year. At the time of entry, a liberal diet was being supplied. At one year, the girl stood up; at seventeen months, she walked; at eighteen months she talked. Her first two teeth appeared at three months. At fourteen months, all the teeth had appeared.

Up to three months of age, the patient was perfectly well. Then she had two teeth, began to be feverish, and became very pale. Every three or four weeks she would have new teeth and each time feverishness, loss of appetite, and gradually increasing pallor would reappear. She showed yellowish discoloration of the eyes, first observed at about twelve months. At eighteen months, slowly progressive swelling of the abdomen began, and the urine became persistently a "sort of coffee-color".

Physical examination disclosed a chronically ill child of somewhat Mongolian facies. The mentality seemed normal. The skin was marked by a muddy palor and of an icteric quality. The hair was fine and dry. The eyes, ears and nose seemed negative. The lips and mucous membranes of the mouth were pale. The tonsils were moderately enlarged. The teeth were thin, unsubstantial looking and frequently carious. Slight coating showed on the tongue. The cervical lymph-nodes were palpable bilaterally as were the inguinals—others were not felt. The thorax, heart, and lungs were negative. The abdomen, however, was dome-shaped, very protuberant, and somewhat tense. The spleen projected downward 10 cm. below the left costal margin and to the right just beyond the median line. The organ was hard, non-tender and smooth to the touch. The liver was likewise smooth, non-tender and hard extending 6 to 8 cm. below the right costal margin. The reflexes showed equal and active knee-jerks and a positive bilateral Babinski. The circumference of the head was 49.5 cm., the chest at the nipple line 50.8 cm. and the abdomen 51 cm. The temperature was 101.2°, the pulse 160 and the respirations 38. The weight was 26 pounds. The admission hæmoglobin was reduced to 35 per cent., the red blood cells to 3,500,000. The white blood cells numbered 29,100 with 42 per cent. polymorphonuclear cells. There were 12 per cent. reticulocytes. The smear showed marked anisocytosis and poikilocytosis, some acromia, and great numbers of nucleated red blood cells.

Previous to the patient's entry, she had been followed in the dispensary for several months. A fragility test was done which showed definite increase of fragility over the control cells but the exact record was lost. A reticulated count demonstrated about 15 per cent. reticulocytes in 300 cells counted. The Wassermann was negative.

In the hospital, the child was given five transfusions of between 125 and 350 c.c. prior to splenectomy over a course of twelve weeks. This raised the hæmoglobin to 50 per cent. and the red blood cells to 4,900,000. Her white blood count diminished, assuming an average of about 12,000 with 50 to 55 per cent. polymorphonuclear predominance and no abnormal white blood cells. Another Wassermann showed a + reaction in both antigens. Three fragility tests were essentially normal as compared with the controls. Four reticulocyte counts gave 12, 3, 3 and 2 per cent. reticulocytes respectively. A twenty-four-hour stool urobilin contained only 2,940 dilution units, but a twenty-four-hour urine urobilin contained 370 dilution units. On another occasion, no urobilin was detected in the urine. Fifteen urine examinations were done—on three occasions, there was a very faint trace of albumen. A few red cells were noted four times and a few white cells were usually seen. Gastric analysis was not done.

Stereoscopic views of the skull showed decalcification of all the bones of the skull and also those of the face. The inner tables of the frontal bones were increased in thickness, but the bone had a mottled spongy appearance. The jaw was markedly decalcified. Films taken five months later showed some increase in the bone porosity, with further widening of the diploë through the frontal bone. There was also some increased thickening through the parietal bone.

Films of both arms and legs indicated mild decalcification. The lower epiphyses of the femora appeared irregular about their margins, as if there had been some disturbance in their development. The lower ends of the femora and shafts of the tibiæ were considerably wider than normal. Thinning of the cortex was slight and trabeculation appeared essentially normal, especially near the ends of the bones, in marked contrast to the patient's sister.

X-rays of the humeri, forearms, hands and ribs proved definitely abnormal. The humeri and the radii seemed larger than usual with distinctly coarsened and irregular trabeculation, thinning of the cortex, and generalized decalcification. These changes were least evidenced in the ulnæ. The ribs maintained essentially the same changes. Comparisons with the X-rays of the sister were striking in the mutual similarity. Repetition after five months showed no change.

The hilum shadows of the lungs were moderately thickened on both sides, and a few small calcified nodes were present. In other respects the lung fields were negative.

The patient improved in strength and general well-being following her transfusions. April 9, 1928, splenectomy was performed by Dr. Allen O. Whipple. At operation he found the spleen about double normal size. The liver did not seem cirrhotic.

Following operation there was an unusual white blood cell response, the counts on the first and second days rising to 40,000 and 51,000 with polymorphonuclear neutrophils at 90 and 87 per cent., though the maximum temperatures were 101.4° and 102.2° only respectively. Ten days after operation the hæmoglobin was 45 per cent., the red blood cells 3,240,000, the white blood cells 20,000 and the polymorphonuclear cells 60 per cent. Nucleated reds numbered 45 to 100 red cells counted. The platelet count was at the high level of 570,000.

Two weeks post-operatively, the child was sitting in a chair, playful, feeling well, without pain.

The pathological report on the spleen stated:

Gross.—The specimen is a spleen which measures 12 x 6 x 8 cm. It seems to have lost a considerable amount of blood so that its measurements were probably much larger in the patient. There are some rather exaggerated notches in the free borders. The capsule is only thickened where the ragged threads of adhesions are attached to it and there are at least five main vessels entering the hylic surface scattered from one end to

the other. On section the splenic tissue seems very firm and the fibrous trabeculæ are easily distinguished. The cut surface does not bulge but the many splenic corpuscles project forward like pallid millet seeds from the dull red background of the pulp. Grossly the vessels appear normal. No hemorrhages are seen.

Microscopic.—Sections of the spleen have been stained with Masson's Ponceau, aniline blue, acid fuchsin and iron hæmatoxylin; with Masson's metanil yellow, acid fuchsin and iron hæmatoxylin and with Scharlach R. The only lesions noted are a mild degree of fibrosis which is generalized and the presence at scattered intervals in the splenic pulp of rather large cells with eccentric nucleus and with the cytoplasm vacuolated. The material in the vacuoles does not stain with Scharlach R which rules out the lipoid bodies. It stains a faint delicate blue with the aniline blue and a very pale yellow with the metanil yellow.

The splenic corpuscles are rather widely separated and the pulp has little blood in it so that the spongy sinuses are easily made out. They contain no unusual type of blood cell. There has not been time to have the spleen analyzed to determine the presence or absence of the cerebroside kerasin, the material which is found in the large cells of Gaucher's disease. The picture in this spleen is identical with that seen in the spleen of this patient's sister (Marie). Whether these scattered cells mean a mild Gaucher's disease or not, I cannot say because I do not believe that the early lesions of the spleen in Gaucher's disease have ever been observed. I have never seen these cells with vacuoles in any other spleen except those of Gaucher's disease.

There is only a small amount of hæmosidirin scattered through the spleen.

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SPLENECTOMY FOR TRAUMA

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TRAUMATIC rupture of the spleen is an extremely serious surgical condition that is not of infrequent occurrence. The reports by Berger,[1] Eisendrath,[2] Bessel Hagen,[3] Planson,[4] Johnston,[5] Barnes,[6] and others who have diligently summarized and critically analyzed many of the case reports in the literature have served to show the necessity for operation in these cases. Except for that admirable chapter by Pool,[7] in his monograph on "Surgery of the Spleen," no sufficiently adequate and authoritative treatment of this subject is to be found in our current text-books on surgery. Recently Bailey[8] reported twenty-nine cases from the records of the London Hospital, and added three personal cases; which included all cases of traumatic rupture that entered the hospital during the thirty-three-year period, 1894 to 1926.

In 1921, I[9] reported in detail six cases of traumatic rupture of the spleen and one case in which a splenectomy was performed for the spontaneous rupture of a normal spleen. In this paper we shall briefly outline our experiences with traumatic lesions of the spleen at Harlem Hospital, and draw therefrom conclusions that seem to be justified. This report is based upon the study of thirty-nine cases of splenic injury; and it includes all cases of traumatisms of the spleen that entered the hospital during the twenty-three-year period, 1905 to 1927 inclusive. An operation or an autopsy proved the spleen to be the injured organ in all cases. There were thirty-two cases of traumatic subcutaneous rupture, one case of spleno-medullary leukemia and six cases of "open" wounds of the spleen.

Subcutaneous Rupture.—The nature of the trauma varied, as indicated below:

Struck or run over by automobiles	18
Run over by a wagon	3
Falls:	
from window	3
down elevator shaft	1
into area-way	1
from carriage seat	1
onto a pile of stones	1
Struck by a motorcycle	1
Struck by falling body of another person	1
Physical assault	1
No history of trauma	1
	32

Automobile accidents produced the greatest number of these cases, and falls, of various kinds, were next in frequency as regards etiology. The

frequency of splenic injuries has shown an increase in direct proportion to the increase in the use of the automobile. This is shown by the fact that in the twelve-year period, 1906 to 1916, there were twelve admissions to the hospital for ruptured spleen, and of these twelve cases, only three resulted from automobile accidents; while in the subsequent eleven-year period, 1917 to 1927, there were twenty admissions for splenic rupture and fourteen of these twenty cases were the result of automobile injury. The one case, in which no history of trauma could be obtained, was of interest from the standpoint of diagnosis. The patient presented all the signs of severe abdominal injury and showed an area of contusion in the left hypochondrium. It was ascertained that he had been drunk for three days preceding admission to the hospital. At operation a ruptured spleen was removed and the patient made an uneventful recovery. It is clear that this patient received some blow or fell injuring himself while under the influence of alcohol, and the only clue to the traumatic etiology in this case was the contusion to the abdominal wall, which in most instances is absent. The lack of history of trauma can occasionally obscure the diagnosis. The age incidence was as follows:

Age (years)	No. of cases
3	1
6	4
7	2
8	4
9	2
10	1
12	1
13	2
14	1
15	1
17	1
18	1
20	1
21	1
25	1
30	1
34	1
36	1
40	1
41	2
50	1
61	1

Twenty-two of the thirty-two cases occurred in persons under twenty-one years of age; eighteen cases occurred between the ages of six and fifteen years, showing that no age is exempt. Traumatic subcutaneous rupture occurs, however, most frequently in children, although the books on surgery of childhood by Barrington-Ward,[10] Fraser,[11] and Campbell and Kerr [12] do not even mention its occurrence. Next in frequency it is found in those in the age period of adolescence. This age prevalence can be explained by

the inability of children to take proper care of themselves in the presence of danger and the recklessness of youth. Another factor is that milder degrees of trauma will produce rupture in children than in adults.

Sex Incidence.—Twenty-five cases occurred in males and seven in females. The spirit of daring and adventure with consequent increased exposure to danger, on the part of boys as compared to girls explains the differences found in childhood; while occupational and industrial hazards explain most of the differences found among adults. Many early writers pointed out the protection afforded women by the use of corsets, which is becoming less and less applicable today, due to the change in style of feminine apparel.

In all cases, excepting one, the spleen, but for the traumatic lesion present, was normal on pathological examination; and in that one case a spleno-medullary leukemia was found. We cannot, therefore, agree with Archibald and Mayo [13] when they state "that in accidents where the spleen is ruptured it will very often be found that a pathological condition existed previously and resulted in enlargement and friability of the organ." Enlarged diseased spleens are, of course, ruptured from milder degrees of trauma, but as regards the normal spleen we would, again, emphasize the fact that the physiological enlargement of the spleen following digestion is a probable factor in these cases of rupture. The traumatic lesion in most instances consisted of a large laceration which divided the organ into two parts. In some cases the laceration was stellate in character, and, occasionally the spleen was represented by a pulpy mass. Only one case showed a very small tear. In one case the splenic vein was also torn. No intracapsular tears were observed, although I did observe it in a case of spontaneous rupture. The abdomen was filled with blood and blood clots in all cases; the blood clots were chiefly around the spleen, and on the left side of the abdominal cavity, while free blood was found in the pelvis.

Seven cases in this series were not operated upon and all seven were fatal. The time period in the hospital and the necropsy findings are shown below:

Case No.	Time in hospital before death	Post-mortem findings
1.	4 hrs. 15 min.	Fractured skull, fractured ribs, ruptured spleen.
2.	11 days	Left lobar pneumonia, left pneumo-thorax, ruptured spleen.
3.	2 hrs. 20 min.	Ruptured spleen.
4.	2 hrs. 50 min.	Ruptured spleen.
5.	2 hrs. 30 min.	Fracture of 7th, 8th & 9th ribs, contusion of base of left lung, ruptured spleen.
6.	1 hr.	Ruptured spleen.
7.	2 hrs.	Spleno-medullary leukemia, ruptured spleen, left empyema.

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Two of these patients refused operation and the case of spleno-medullary leukemia was seen in surgical consultation, in the medical ward too late to be saved by operation. The lack of operation in the four remaining cases, which occurred early in our experience, was due to errors in judgment, in that all of these patients were in extreme shock and the delays caused by our attempts to combat shock were fatal. We are confident that one or two of these cases might have been saved by immediate operation. We are more and more on the lookout for these cases now and their occurrence is becoming increasingly rare.

The frequency of associated lesions is indicated in the following table:

Case No.	Splenic and Associated Lesions	Result
1.	Ruptured spleen	Cured.
2.	Ruptured spleen, laceration tail of pancreas	Died.
3.	Ruptured spleen, lacerated wound of greater curvature of stomach, retroperitoneal hemorrhage	Died.
4.	Ruptured spleen, perforation midportion of intestine	Died.
5.	Ruptured spleen	Died.
6.	Ruptured spleen, fracture 7th rib	Died.
7.	Ruptured spleen, lac. rt. lobe of liver, and injury to splenic vein	Died.
8.	Ruptured spleen	Cured.
9.	Ruptured spleen	Cured.
10.	Ruptured spleen	Cured.
11.	Ruptured spleen	Died.
12.	Ruptured spleen	Cured.
13.	Ruptured spleen	Died.
14.	Ruptured spleen, small laceration of liver	Cured.
15.	Ruptured spleen	Cured.
16.	Ruptured spleen	Cured.
17.	Ruptured spleen	Cured.
18.	Ruptured spleen	Cured.
19.	Ruptured spleen, concussion with fracture of skull, traumatic synovitis, knee-joint	Died.
20.	Ruptured spleen	Died.
21.	Ruptured spleen	Cured.
22.	Ruptured spleen	Cured.
23.	Ruptured spleen	Cured.
24.	Ruptured spleen	Cured.
25.	Ruptured spleen	Cured.

In eleven, or 29.1 per cent. of our cases associated lesions were present; the frequency of its occurrence is somewhat less than that indicated by DaCosta,[14] when he states that "traumatic rupture is rarely found unassociated with other injuries." Only four operative cases died where the pathology consisted of rupture of the spleen alone, while in the other six fatal cases, there were injuries in addition to that of the spleen. On the other hand, of the fifteen cured cases, only one presented an associated lesion, and the lesion in that case in addition to the splenic injury was a small laceration of the liver. In only three of the non-operated cases was the spleen alone

injured. The presence or absence of associated lesions, have, in our opinion, a very distinct bearing on operative mortality. Prognosis is always worse when additional injuries are present, as ten of these eleven cases were fatal. Splenic rupture, in the absence of associated lesions, is not apparently, quite as serious a condition, as has been generally assumed.

The symptoms and signs of ruptured spleen are chiefly those of shock and hemorrhage. Marked variations in degree occurs in different cases, and no two cases are exactly alike. Many patients do not survive the initial shock, and, in these cases of immediate death, hemorrhage is the causative factor. In many instances the diagnosis of rupture of the spleen is impossible before operation. The clinical picture presented is, obviously, that of a grave abdominal injury due to trauma. Pool points out the fact, that there is, in some cases, a distinct latent period between the subsidence of the signs of shock and the development of the signs and symptoms of internal hemorrhage. The recognition of this point will lessen mortality, because if a patient is operated upon during this interim, before the evidences of internal hemorrhage are marked, the operative risk would be reduced in these particular cases. In this series, three patients did not show any signs of hemorrhage for the twenty-four-hour period following admission, and of interest is the fact that these three patients showed a slight rise in temperature which we believe to be important as indicating the passing of the initial shock. Lejars [15] records a case in which twenty-four days elapsed between the time of the injury and the development of profound symptoms, and Jackson [16] reports a case in which twenty-eight days elapsed, and in both of these cases the signs and symptoms were those of intra-abdominal hemorrhage.

All our patients, excepting one, were conscious and rational upon admission. This one exception was semi-conscious as a result of skull fracture. In two cases a history of immediate but brief loss of consciousness following the injury was obtained. Robitshek [17] in listing the symptoms found in 128 cases does not even mention it; while Bailey, who noted its occurrence in three consecutive cases, considers it of great diagnostic importance. Apparently it is only incidental.

All patients complained of abdominal pain. In most instances it was localized in the left hypochondrium, but in others it was generalized throughout the abdomen. In only one case was Kehr's sign, or pain in the left shoulder, present; and in this case the patient was injured the day preceding his admission to the hospital. He gave a history "of being unable to sleep the previous night because of a sharp, cramp-like pain in the left side of the abdomen, which was aggravated by breathing, but in the morning the pain moved to his left shoulder." Brogsitter [18] thinks "that pain in the left shoulder is of little diagnostic importance, as it is seen in other instances of injury of abdominal organs, particularly of the left lobe of the liver." Abdominal pain is invariably the chief complaint of these patients.

Vomiting occurred in seven cases, or 21.7 per cent. pre-operatively, after admission. The vomitus was brownish or coffee-ground in color. Robitshek reports vomiting in thirty-five out of 120 cases, or 27.7 per cent. Bailey considers "the absence of vomiting a point of some diagnostic importance, in that it is against the chance of the case being one of ruptured spleen;" and Melchior [19] also thinks that vomiting is rare in splenic rupture. On the other hand, Trendelenburg [20] states "that vomiting is a guide as it is usually absent in cases of injury to the alimentary canal." It is our opinion, that vomiting occurs sufficiently frequent to be a symptom of some diagnostic value. In two cases, in this series, enemata provoked vomiting. Enemata pre-operatively are dangerous, in that they may give rise to a sudden marked and alarming increase in the hemorrhage where the existent hemorrhage is slight or delayed, as happened in several of our cases, and is beautifully illustrated in Doughtie's [21] case, although apparently unrecognized by him. Because of the possibility of aggravating hemorrhage the giving of enemata before operation in cases of suspected ruptured spleen is definitely contra-indicated. This holds true in all cases of suspected intra-abdominal injury.

Dulness on percussion in the left flank was found in sixteen cases and is a symptom of importance. Obliterated liver dulness was noted in three cases. Ballance's sign, or shifting dulness in the right flank, with fixed dulness in the left flank was observed in only one case.

Abdominal distention was present in all of our cases and is a symptom that must be duly considered.

Palpation has been a very valuable aid in these cases of suspected splenic rupture but it must be carefully applied. In eight of our cases we made a tentative diagnosis of splenic injury which was verified at operation. This feeling can best be described by comparing it to that found in the early stages of tuberculous peritonitis.

Abdominal rigidity was found in all our cases but we have to consider that the rigidity may be caused as much by the trauma to the abdominal wall which produces the injury as to the injury of the abdominal organ itself.

The admission temperature usually ranged from subnormal to 100 degrees; nine cases showed a temperature of 100 degrees and the highest temperature noted was 101.6 degrees. The average admission pulse was rapid and weak and at times was almost imperceptible. Generally the pulse rate varied between 120 and 140, while five cases showed a pulse rate of less than ninety-four. The admission respiratory rate varied between twenty and fifty; the average was twenty-four to thirty. The admission temperature, pulse rate and respiratory rate findings are presented only to illustrate the usual variations found. A careful study of the pulse is essential, and its diagnostic and prognostic value cannot be overestimated. The symptoms and signs of shock and internal hemorrhage are too well known to warrant further comment.

Ten cases showed external evidences of bodily injury, and they were as follows:

Abrasion of the scalp 1
Laceration of the scalp 1
Subcutaneous emphysema due to fractured ribs 2
Contusion of left hypochondrium 1
Fractured femur 1
Contusion of left orbital region 1
Contusion of back 1
Abrasion of ribs at level of ensiform 1

Only three cases showed any external marks on the abdomen or back. Twenty-two cases in this series presented no visible marks of injury on their bodies; and it is our opinion that in these cases the force is transmitted through the abdominal muscles, while they are relaxed, and the internal organs receive the full brunt of the violence. A large hæmatoma or contusion of the belly wall is produced by the action of the force against taut abdominal muscles; and, according to our experience, there is usually no visceral injuries, as the force spends itself against the abdominal wall. This applies to all cases due to trauma, where considerations of possible internal injury enter. The absence of external marks on the abdomen has been noted by numerous observers; but its importance as regards diagnosis, has been rarely or never stressed. Following a history of severe trauma in a case showing abdominal symptoms the absence of marks on the body is a point that is greatly in favor of internal injuries of a grave nature, as most cases of traumatic rupture of a viscus do not present body marks.

The admission blood examinations showed the usual changes attributable to hemorrhage, namely a varying leucocytosis, with a constant increase in the polymorphonuclear leucocytes; and a variable but almost constant and corresponding decrease in the hæmoglobin estimate and the red blood count. The white blood counts ranged between 9,000 to 48,000 white blood cells, and averaged between 12,000 to 18,000 white cells, and the polynucleosis, which varied between 72 per cent. to 90 per cent. of polymorphonuclear cells, averaged between 80 and 85 per cent. The red blood count was practically always decreased, and the average was between 3,000,000 and 3,500,000 red blood cells; while the highest and lowest counts observed were, 4,900,000 red blood cells and 2,700,000 red blood cells, respectively. In every case but one, there was a corresponding decrease in the hæmoglobin estimation, and the average was between 60 and 70 per cent. The highest hæmoglobin estimate noted was 95 per cent. and in this case the red cell count was 4,900,000, and the white blood count was 16,000 leucocytes, with 84 per cent. polymorphonuclear leucocytes. The blood findings indicate in general concealed hemorrhage, and from that point of view, they are of important diagnostic value. The work of Cannon,[22] must however be kept in mind, as he showed that in severe traumatic shock without hemorrhage as a complicating factor, the capillary red blood count may be very high, and may amount to 6,000,000 red blood corpuscles, while the venous count is always lower. Hemorrhage always reduces the high capillary count.

In three cases the urine examination showed gross and microscopic

blood and these three cases were fatal. Autopsy showed a laceration of the left kidney. There were no other urinary findings of significance.

A pre-operative diagnosis of ruptured spleen was made in eight cases; six cases were diagnosed as rupture of the intestines, and in the remaining cases the diagnosis was intra-abdominal injury with hemorrhage.

The treatment of splenic rupture is immediate operation in all cases, and splenectomy is the operation of choice. Twenty-five patients were operated upon, with fifteen recoveries and ten deaths which makes our operative mortality 40 per cent. This is higher than the published operative mortality of most observers, and most comparative studies of published mortality statistics in these cases give but an imperfect representation of the actual conditions. The reason for this is, that there are many factors involved, which in themselves vary in degree and extent, such as the nature and degree of the trauma, the extent of the pathological lesion, the degree of the hemorrhage, the presence or absence of associated lesions, the time elapsing between injury and operation and also the usual tendency on the part of observers to report more often operative recoveries than operative deaths. Many studies of each factor separately, and in a detailed way are needed; and based on these findings, a scientific grouping should be made; and from a study of a large number of properly classified cases, it will be possible to draw sound conclusions. To delay operation or to palliate is to invite disaster. Spontaneous recovery has been reported, but in the light of our present knowledge the chances of such are practically nil, and we are becoming increasingly more skeptical of its occurrence.

Splenectomy was the operation performed in twenty-four cases, and in one case a small tear was sutured. The one case in which a suture was used died, but death in this case was due to peritonitis. Lamarchia's case as cited by Moynihan,[23] illustrates an unusual possibility of danger in these cases where suture of the spleen is done; in this case a tear on the inner surface of the spleen was sutured, but death occurred from hemorrhage from an unnoticed wound on the posterior border.

Sprengel's incision was used in eight cases where a pre-operative diagnosis of ruptured spleen was made, because of the excellent exposure it affords, while in the remaining cases a left rectus incision was used. At times it was necessary to make a horizontal incision, to the left, and about the middle and at right angles to the vertical incision; but in no instance did it seem necessary to resect the costal border, as is done by Auveay.[24] Neither is the submammary incision and subperichrondal section of Doyen,[25] or the transdiaphragmatic approach, that is so warmly advocated by de Tarnowsky [26] to be recommended; as, in our opinion, they unnecessarily prolong the operation.

Recovery has occurred following packing alone where the lesion was small and superficial. Gibbon,[27] in 1908, advocated "judicious packing" and stated "that any case that lives four to five days after rupture can be saved without splenectomy;" which, of course, has been proven not to be the case.

That a rupture may be present, be overlooked at operation, and eventually cause death is shown by Lejars' case.

A study of this material was made as to the effect on the outcome of the time in the hospital before operation; and also the time that elapsed after operation in the fatal cases.

Case No.	Time in hospital before operation	Hrs. elapsing after operation in fatal cases	Result
1.	6 hrs.		Cured.
2.	6 hrs. 15 min.	4 hrs. 10 min.	Fatal.
3.	No record	died on table	Fatal.
4.	4 hrs.	6 hrs.	Fatal.
5.	2 hrs.	6 hrs.	Fatal.
6.	6 hrs. 30 min.		Cured.
7.	8 hrs.	14 hrs. 30 min.	Fatal.
8.	50 min.	1 hr. 15 min.	Fatal.
9.	6 hrs. 40 min.		Cured.
10.	6 hrs. 40 min.		Cured.
11.	4 hrs. 20 min.		Cured.
12.	3 hrs.		Cured.
13.	1 hr. 50 min.		Cured.
14.	12 hrs. 30 min.		Cured.
15.	6 hrs.		Cured.
16.	3 hrs.		Cured.
17.	1 hr. 50 min.		Cured.
18.	4 hrs. 15 min.		Cured.
19.	2 hrs. 55 min.		Cured.
20.	6 hrs. 15 min.	17 hrs.	Fatal.
21.	No record		Cured.
22.	4 hrs. 15 min.		Cured.
23.	3 hrs.		Cured.
24.	4 hrs.		Cured.
25.	2 hrs.	10 days	Fatal.

The average time in the hospital before operation was five hours. The time the patient was in the hospital before operation seemed to have within certain limits but little relation to the outcome. Death occurred in nine of the ten fatal cases within seventeen hours after operation, and this may be safely explained on the basis of post-operative shock; therefore, all of the cases, excepting one, that were able to withstand the operative shock survived. The one case that lived ten days, developed a temperature of 104, a pulse rate of 146 with distention and rigidity of the abdomen, which was probably due to peritonitis. Autopsy was refused.

Blood transfusions helped markedly in the ultimate outcome in this series. Transfusion was employed post-operatively. Saline infusion was used in all cases. Autotransfusion, as recommended by Theis and Henschen [28] was never used.

Infection of a persistent character of the abdominal wound developed in five cases; these five cases developed ventral herniæ. One patient had

a severe hemorrhage from his wound on the ninth post-operative day which we think was due to injury to the pancreas at the time of his accident or at operation, and the pancreatic enzymes digested the suture material and the edges of the wound. This patient developed a massive hernia, indicating that the entire abdominal wall was affected, and which required a secondary suture. In the London Hospital series, four cases of "burst wounds" were reported, and in each case the wound had to be resutured under general anæsthesia; Bailey attributes this to the action of the pancreatic ferments, as indicated by me in a previous paper, as the probable cause of the persistent infections and post-operative herniæ that occurred in our cases. A left-sided empyema occurred in one case thirteen days after operation; we think this was due to infection of a traumatic pleurisy produced at the time of the original injury. In support of this idea is the fact that one of our non-operated cases showed at autopsy a contusion of the base of the left lung; and Bailey reported three cases of left-sided pleurisy in his group of thirty-two cases. No persistent hiccough as observed by Bailey in several of his cases was noted by us.

The average stay in the hospital of the cured cases was thirty-two days.

No opportunity has presented itself for me to do a second operation on any of my splenectomized patients.

Griffin [29] states "that hyperplasia of lymphatic tissues has been seen occasionally during life, and has been definitely found post-mortem following splenectomy in man." Faltin and Stubenrauch [30] found at the time of second laparotomies, one and six years, respectively, that the peritoneum was covered with numerous nodules, showing microscopically the characteristics of splenic tissue, which certainly had not been present at the first operation. Moynihan [31] reports a personal case, in which a small accessory spleen, after a period of seven years, increased almost to the size of a normal spleen. Lee [32] described a case in which a laparotomy was performed for acute intestinal obstruction on a splenectomized patient, and he found the peritoneum covering the small intestine and mesentery covered with small tumors, varying in size from a pin head to one inch by one-half inch; there were 200 to 300 such tumors, and on microscopic examination they were found to be of splenic tissue. It is, therefore, clear to a certain extent at least, that after splenectomy, the functions of the spleen are taken over by remnants of splenic tissue left at operation, accessory spleens and the rest of the reticulo-endothelial system; all of which show hypertrophy. In a case of apparent congenital absence of the spleen Hodenpyl [33] found at autopsy a general compensatory lymphatic hyperplasia.

Pearce,[34] Asher,[35] and others, have found that the spleen plays an important part in iron metabolism. Asher found that the elimination of iron was considerably increased in splenectomized dogs. Bayer [36] observed an increased iron excretion in several splenectomized patients. Pearce has shown that the spleen controls and regulates blood destruction; and, is of the

opinion, that the increased iron elimination is to be explained by increased blood destruction. The bone marrow, according to Mosler,[37] becomes red after splenectomy, due to hyperemia, and there are active mitotic figures, and there is an increase in the number of specific marrow cells with a diminution in the amount of fat; these changes, Pearce thinks have to do with the storage of iron.

Following operation in this group of cases, examination of the blood showed a secondary anemia. The decrease in the number of red cells, was accompanied by the usual variations in size, shape and staining qualities that are found in anemia; evidences of red cell regeneration were shown by the presence of normoblasts. Granular basophilic degeneration, or Grawitz's granules, as noted by Morris [38] in one case, was observed by us in one instance; the red cells showing this punctate basophilia disappeared from the blood in about two weeks after operation. The normoblasts disappeared from the peripheral blood in from ten to fourteen days but did not reach normal during the stay of the patients in the hospital. The white blood count remained high for three to five weeks and it varied from 14,000 to 30,000 leucocytes. An increase in small lymphocytes was invariably noted, and it amounted to as much as 45 per cent.; a small but constant increase in large mononuclears, and transitional cells were observed. White cell regeneration was evidenced by the occurrence of eosinophilic and neutrophilic myelocytes in some cases; these abnormal cells appeared about the end of the first week, reached their zenith between the second and third weeks and disappeared during the fourth and fifth weeks after operation. No eosinophilia was observed during the hospital stay of any of the patients. No studies of the fragility of the red blood cells were made in these cases, which according to Moynihan, is increased. No platelet counts were made by us, but Rosenthal [39] studied the effect of removal of the normal spleen on the blood platelet count, in seven cases at Mt. Sinai Hospital, and he found that "there was a gradual and constant increase in the number of blood platelets. This increase reaches its zenith during the second week. Blood platelet counts of 1,000,000 to 1,900,000 were observed. The platelet count begins to drop and becomes normal or remains somewhat above normal about the third or fourth week after operation. Observation of these cases for five years after operation has shown their platelet count to be normal or slightly above normal." Moynihan [40] is of the opinion that the "temporary anemia subsides in about two months' time, and that the increase in lymphocytes persists for about a year, and gives place to an eosinophilia, which increases to about 8 per cent. during the third year." Boyd [41] states definitely that "the anemia disappears at the end of two months." Pfeiffer and Smyth,[42] state that "individuals splenectomized for traumatic rupture usually show a definite and persistent anemia, which requires prolonged observation and treatment." Examinations have been made of the blood in a number of our cases for a period of three years or more and in one

for a period of seventeen years, and every case showed a slight secondary anemia and a slight leucocytosis. The blood picture found in the one case seventeen years after splenectomy is to wit:

Red blood count 4,800,000
Hæmoglobin ....75 per cent.
White blood count 13,000
Polymorphonuclears ....70 per cent.
Lymphocytes ....30 per cent.

As to the late effects of splenectomy on the physical welfare of these individuals: No untoward effects were discovered. We have observed one case for seventeen years and he has always been in excellent condition from his history and physical examination, excepting for a very mild anemia. Regular periodic health examinations were carried out for short periods of time in these cases but it was impossible to make observations for more than three years and they were all in excellent physical condition at the time of their last examination. There was no evidence of decreased resistance to infection in these cases. This is contrary to the conclusions drawn by Morris and Bullock,[43] as they state "that there is often noted clinically decreased bodily vigor and resistance." Attention has been called to the inherent fallacy of all conclusions drawn from experimental work by Michelson [44] and Rost [45]; and they point out the fact that after splenectomy, as after the operative removal of any abdominal organ, the body is necessarily in a weakened condition, and therefore any infection may develop, and is more virulent. Observations on splenectomized animals, in all work reported to date, have not been carried out for a sufficiently long period of time after operation. Rost also states that "there is no evidence of any decreased resistance of splenectomized persons to infection." Moynihan's opinion is the same, and Bailey could find no decreased resistance to infection, in the follow-up of his patients after spenectomy. Late deleterious effects of splenectomy on health are apparently absent, and if present, they are, for practical purposes, negligible.

Open wounds: These penetrating wounds consisted of five gunshot wounds and one stab wound. They are rare in military surgery and still rarer in civil practice. Laspeyres [46] reported seven splenectomies with three recoveries. Abadie [47] reviewed twelve cases of war injuries of the spleen operated upon by Depage,[48] and of these twelve splenectomies four recovered. Willems,[49] as quoted by Abadie, states, "that splenectomy is constantly fatal in military surgery" and his conclusion was based on the fact that he lost five consecutive cases in which splenectomy was performed. General Ireland in a personal communication to Pool, reports that the incomplete records for our troops in France show that ten splenectomies were performed and eight of the ten were fatal. Open wounds of the spleen are fatal unless an immediate operation is performed. Splenectomy is the operation of choice and we feel that Abadie is correct in pointing out that

splenectomy is serious in proportion to the already existing hemorrhage and to the injuries of the other organs which have already threatened the patient's life. Stetten [50] reported a stab wound of the spleen, which was treated by suture, and the patient recovered.

Owing to the scarcity of published reports of open wounds of the spleen, it seemed that a report of the following six cases might prove of interest.

CASE HISTORIES

CASE I.—*Stab wound of the spleen.* Male, age twenty-four years, was admitted to the hospital, July 23, 1906, at 12:30 A.M. with a stab wound in the left flank. The wound was three-fourths of an inch in length, and was located between the tenth and eleventh ribs, about five inches from the spinous process of the twelfth dorsal vertebra; and it passed upward into the abdominal cavity. The wound was bleeding profusely. Liver dulness was obliterated. Temperature on admission was 100, pulse 120, and patient was in shock. At operation the spleen was found to be pierced through about an inch from its lower border and was bleeding profusely from the inner aperture. The spleen was removed. There was a hemorrhage under the serous coat of the colon, and a wound in the mesentery. Three days after operation the patient developed a temperature with distention of the abdomen; the wound was opened and drained but no pus was found. He became very septic and died the following day.

CASE II.—*Gunshot wound of spleen.* Male, age twenty-six years, was admitted to the hospital, January 21, 1905, at 9:00 A.M. Patient was found on the sidewalk in shock. Temperature 99.4, pulse 150. On examination he was pale and dyspnœic and showed a bullet wound in the left shoulder, two bullet wounds in the left thigh and one in the back about three inches to the left of the midline and under the rib. The abdomen was rounded, tense, and was dull on percussion in the flanks, but tympanitic over the centre, and was diffusely tender. Operation was performed one hour after admission, and on opening the abdomen through a left rectus incision, a considerable quantity of dark blood escaped. The spleen was markedly enlarged from intracapsular hemorrhage and showed a deep furrow on its external phrenic surface, which was bleeding profusely. The spleen was removed. The condition of the patient was extremely poor while on the table and during this time an intravenous injection of normal saline was given. After his return to bed he vomited several times moderate quantities of bile-colored and coffee-colored material and was treated by gastric lavage. The pulse rose steadily, however, and he died thirty-six hours after operation.

CASE III.—*Gunshot wound of the spleen.* Male, age thirty years, was admitted to the hospital, July 5, 1906, at 1:00 P.M. He was shot in the left axillary space and was suffering great pain and also complained of nausea. On examination the patient was conscious, pale, in a cold sweat; the mucous membranes were almost white. The abdomen was rigid, tender and dull on percussion in both flanks. In the anterior axillary line between the tenth and eleventh ribs there was a bullet wound of entrance from which blood was oozing. At operation, one-half hour later, through a left rectus incision, the spleen was found to be perforated and it was removed. A perforation was found in the diaphragm and the sucking of air indicated injury to the left lung. A Mikulicz tampon was placed beneath the diaphragmatic opening. The patient made an uneventful recovery and nothing unusual was noted except that the urine was bloody for several days after operation.

CASE IV.—*Gunshot wound of the spleen.* Male, age twenty years, was admitted to the hospital, December 27, 1907, at 10:30 A.M. Temperature 99, pulse 134, respiration 50. Patient was said to have been shot in the back and when first seen he was in extreme shock, pale and pulseless. He was treated for shock and showed some reaction.

He complained of abdominal pain. The abdomen was rigid and tender throughout. Operation was performed two hours later. A midline incision was used and the abdominal cavity was filled with blood. Perforation of the spleen and liver. The spleen was removed and an iodoform drain was inserted down to the wound in the liver which was not apparently bleeding at the time. The bullet was found free in the abdomen. The patient died four hours after operation.

CASE V.—*Gunshot wound of the spleen.* Male, age twenty-one years, was admitted to the hospital, August 5, 1911, at 9:45 P.M. He was shot in the abdomen and complained of abdominal pain. The wound of entrance was in the epigastrium, and the bullet was felt beneath the skin, on the left side of the back. On examination, patient was conscious and pale. Temperature 100, pulse 92. The abdomen was slightly rigid in the left upper quadrant and was slightly tender over splenic area. At operation, four hours later, the abdomen was opened through a left rectus incision and a large amount of free blood was found; the spleen was found to be lacerated and it was removed. A circular opening in the greater curvature of the stomach was found near the pylorus and this was closed by suture. Bleeding points in the gastro-omentum were ligated. Recovery was uneventful.

CASE VI.—*Gunshot wound of the spleen.* Male, age forty-one years, was admitted to the hospital, April 23, 1922, at 8:00 A.M. Temperature 98.6, pulse 92. Patient was found in a coal cellar with three bullet wounds over the precordium. He stated that he had shot himself. The three bullet wounds of entrance were on the left side at the level of the fifth interspace in the mid-clavicular line. One wound of exit was just below the twelfth rib, about three inches to the left of the spine. There were powder marks around the three wounds of the chest, which were separated from one another by a distance of one-half inch. The patient was pale and in great pain. Rigidity of the abdomen was found in the left hypochondrium. Operation was performed one hour later and through a left rectus incision the abdomen was opened and found to be filled with blood. The spleen was torn and there was active bleeding from the splenic vessels. A large perforation was present in the diaphragm on the left side which sucked in air with each inspiration. The condition of the patient became so poor during the operation that the vessels at the root of the spleen were tied with tape and the free ends brought out through the abdominal wound. The perforation in the diaphragm was closed with a Mikulicz drain and the area about the spleen was packed with iodoform gauze. The patient did not rally from the operation and died twenty-four hours later.

In the five gunshot wounds the spleen alone was injured in only one case, two cases had perforations of the diaphragm, one a perforation of the stomach and in the fifth there was a wound of the liver. In the stab wound case there were associated injuries to the colon and mesentery. In this series we had a mortality rate of 66 and 2/3 per cent. which is in keeping with the published statistics of other observers.

SUMMARY

To summarize we may say:

1. Traumatic rupture of the spleen occurs most frequently in childhood and adolescence.

2. The absence of external marks on the body of a patient presenting abdominal symptoms following trauma is an important diagnostic clue.

3. Immediate operation should be performed, regardless of the condition of the patient and splenectomy is the operation of choice.

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[39] Rosenthal, N.: Personal Communication.
[40] Moynihan: The Spleen, and Some of Its Diseases, W. B. Saunders Co., 1921, p. 21.
[41] Boyd: Surgical Pathology, W. B. Saunders Co., 1925, p. 591.
[42] Pfeiffer and Smyth: ANNALS OF SURGERY, 1924, vol. lxxx, p. 560.
[43] Morris and Bullock: ANNALS OF SURGERY, November, 1919, vol. lxx, p. 513.
[44] Michelsen: Ergebuisse der Chirurgie and Orthopaedie, 1913, vol. vi, p. 480.
[45] Rost: Pathological Physiology, P. Blakiston's Son and Co., 1923, p. 152.
[46] Laspeyres: Cited by Moynihan in "Abdominal Operations."
[47] Abadie: Medical and Surgical Therapy, D. Appleton, 1918, vol. iii, p. 512.
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[49] Willems: Quoted by Abadie. (*Ibid.*)
[50] Stetten: ANNALS OF SURGERY, March, 1923, p. 370.

SPLENECTOMY

REPORT OF A CASE WITH PATHOLOGY UNCLASSIFIED *

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AND

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of Cleveland, Ohio

THE following case report is offered to show that even in cases of splenomegaly which are atypic, splenectomy may prolong or save the life of the patient.

The patient, a man thirty years of age, came to the Clinic July 29, 1927, complaining of pain in the left side, a fissure in ano, loss of weight, sleeplessness. He had had the fissure since February. The pain in the left side started two weeks before this visit, beginning as a sharp pain. It was especially evident when the patient stooped over and when he took a deep breath. The patient had had no cough but had had a slight fever. He had lost about fifteen pounds in weight.

There was nothing of significance in the family or personal history. As to his present illness there were no symptoms referable to the digestive, cardiovascular or respiratory systems except shortness of breath which was due to the pain. He tired easily and stated that he slept poorly.

Physical examination revealed a tall, slim man weighing 142 pounds (normal weight 154 pounds). His temperature was 100°F., his pulse rate 92. On respiration there was diminished movement of the left side with suppression of breath sounds over the left base. There were no râles. In the abdomen there was a visible mass in the left side extending over the splenic area to the midline and below the umbilicus. This mass was slightly tender on palpation, and there were definite coarse crepitations over the spleen. There was a small indurated area on the left buttock about one and a half inches from the anus which was discharging feces.

Aside from the fistula the clinical impressions were splenomyelogenous leukemia, Banti's disease or tuberculosis of the spleen.

An X-ray examination of the chest gave the following information: A short cervical rib on the left side; the left diaphragm level with the right or slightly elevated; fibrotic infiltration in the lungs extending well out into the infraclavicular region.

August 9, the spleen appeared to be very large; it filled Traube's space and extended medially to the midline. A notch was felt at the umbilicus but the lower pole extended almost to Poupart's ligament. The surface was slightly irregular but the consistency was not very hard nor was the edge very sharply defined. It did not feel like a leukemic or Banti's spleen, and was scarcely firm enough to be an amyloid spleen. It felt more like an enlargement due to a chronic infection such as tuberculosis or lues. X-ray therapy and potassium iodid were advised, to be followed by splenectomy if these measures were not effective.

Six weeks after receiving X-ray treatment the patient had gained thirteen pounds and felt much better. At this time the spleen extended only to the level of the umbilicus.

A von Pirquet test, October 7, was positive.

November 3, the spleen felt smooth, was very firm, and extended the breadth of three fingers below the umbilicus. On account of the accompanying fistula in ano and the positive von Pirquet, it was believed that this was a tuberculous or possibly an amyloid spleen and splenectomy was advised.

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* Read by title.

The successive blood counts to this time are shown in Table I.

At operation, November 11, a spleen weighing 2900 gm. and measuring 30 x 7 x 18 cm. was removed. (Fig. 1.) The liver was found to extend for almost a hand's breadth below the costal margin. It seemed to be normal in color and there was no evidence of cirrhosis.

A transfusion of 500 c.c. of blood was given immediately after the operation.

Pathological Report.—Gross description: A spleen weighing 2900 gm. and measuring 30 x 7 x 18 cm. It is deeply notched, smooth and flabby; and the capsule is tense. The anterior surface is dull white and lustrous. Serial sections show a dark red, velvety cut surface with absence of markings of the splenic nodules; considerable
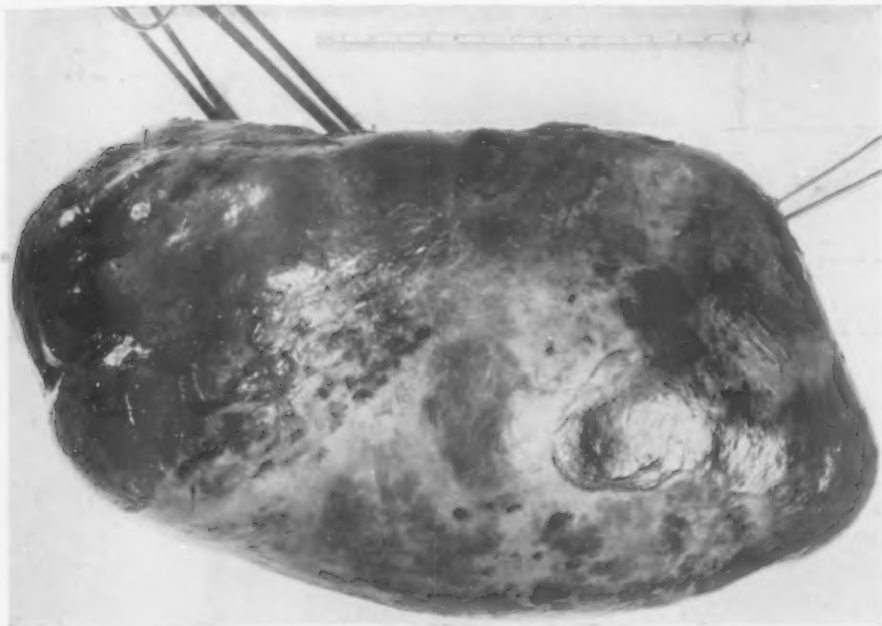
FIG. 1.—Gross specimen of spleen weighing 2900 gm. and measuring 30 x 7 x 18 cm.

pulp is obtained on scraping. A single, discrete, pale yellow, firm nodule 15 mm. in diameter lies immediately beneath the capsule on the anterior surface. The cut surface of this nodule is homogeneous and smooth. The zone surrounding the nodule is dark red and hemorrhagic in appearance.

Microscopical Description.—The sections show a loss of the Malpighian corpuscle markings. The endothelial leukocytes are greatly increased in number with proliferation of the lining cells and filling of the sinuses. A large number of lymphocytes are present in the sinusoids. In some places these appear to have a separate delicate reticulum suggesting lymphoblastoma. The endothelial leukocytes show a few mitotic figures, and those lying in the sinuses contain hæmosiderin. A few of the smaller vessels show a thrombosis. The picture is suggestive of an aplastic lymphoblastoma. (Figs. 2 and 3.)

Tentative Pathological Diagnosis.—Lymphoblastoma—aplastic type.

Post-operative Course.—The wound healed rapidly and the patient had a smooth convalescence.

The successive blood counts during his stay in the hospital are given in Table I.

February 17, 1928, the fistula in ano was excised.

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Fig. 2.—Photomicrograph (x140) of section of spleen removed in case of splenomegaly. Note marked proliferation of endothelioblasts and loss of Malpighian corpuscle markings.
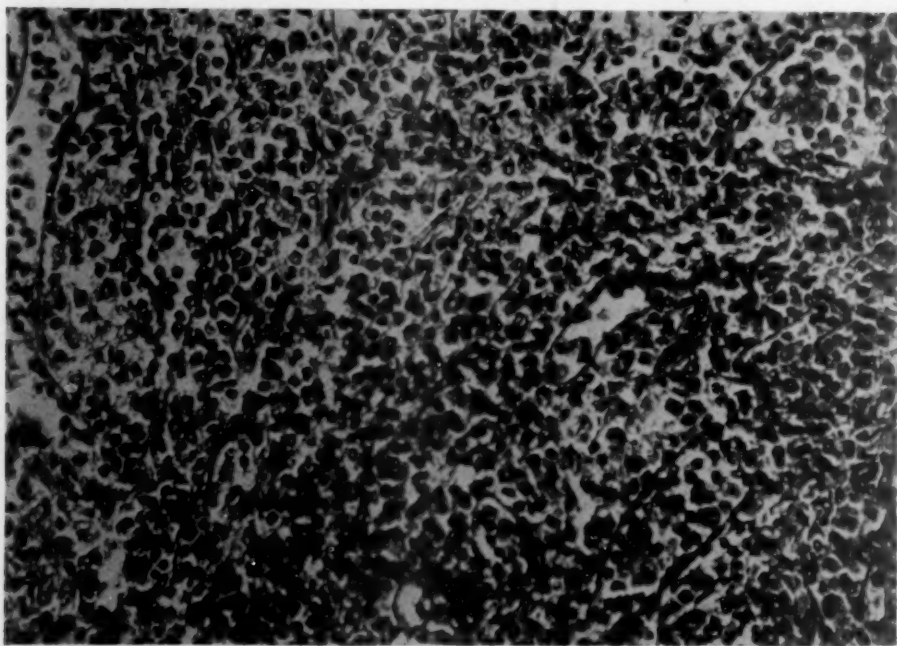
Fig. 3.—Photomicrograph (x250) of section of spleen removed in case of splenomegaly. Note the greatly increased number of endothelioblasts and the filling of some of the sinusoids with lymphocytes and endothelioblasts.

When last seen, March 15, 1928, the patient was feeling well and was sleeping well. His blood count on this date is given in Table I.

On account of the uncertainty as to the pathological diagnosis, sections were sent to various pathologists from whom the following reports have been received:

(1) Chronic myeloidization of the spleen, with anemia. What this condition really means, I am far from certain.
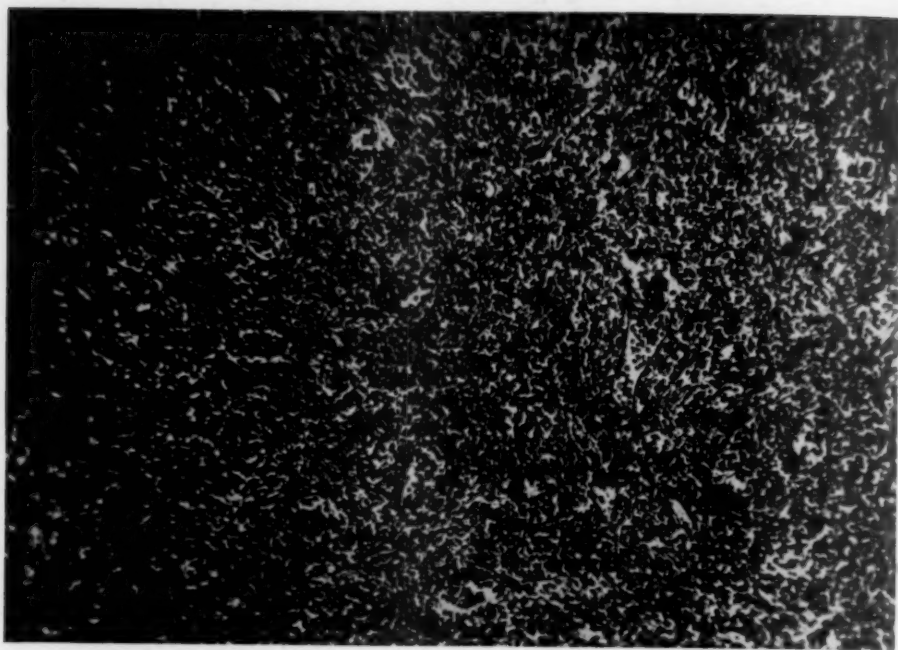
(2) Endothelio-blastic proliferation, microscopic not pathognomonic of any lesion.

(3) Thrombophlebitic splenomegaly.

(4) Stasis with endothelio-blastic proliferation, thrombosis and minute infarcts. Usually associated with a thrombosis of a splenic vein.

(5) Aplastic type of splenomyelogenous leukemia.

TABLE I.

Successive Blood Findings in Case of Splenomegaly with Unclassified Pathology.

Date	R. B. C.	W. B. C.	Ng.	Differential Count			Trans.
				Neut.	S.in lymph.	Lg. lymph.	
7–29–27	4430000	2700	80	45	51	1	
7–30–27		2000					
8– 1–27	4480000	1900	85				
9–29–27	4200000	2000	85	32	58	10	
11– 4–27	4300000	1800	90	39	38	17	
	Operation—Splenectomy						
11– 8–27	3710000	3300	75				
11–10–27	2910000	2100	75	44	16	28	12
11–14–27	3620000	7000	70	70	15	15	
11–16–27	2880000	7300	55–60				
11–18–27	2900000	7800	60				
11–21–27	3600000	6300	60				
11–25–27	2450000	4100	55–60				
11–26–27	3200000		60				
11–28–27	2560000	3800	55–60				
12–12–27	3260000	6050		21	70		3
					(6% mononuclear)		
1– 4–28	3120000	3800	65	13	78	1	3
				(Marked increase in central pallor 2% myelocytes B)			
2–16–28	3520000	4800	80	5	75	20	
3– 6–28	5140000	7850		3	72	14	11

Discussion.—There is no system in the body regarding the pathology of which so little is known as the reticulo-endothelial system; and there is no system the diseases of which are fraught with graver menace. The spleen, in particular, occupies a unique position even within this system, for it is apparently of little, if any, value after birth; as far as is known the diseases which affect it have their origin in other organs, and once it has become involved in a disease process, the progress toward a fatal termination is usually unaffected by any form of treatment except in certain instances by the removal of the organ itself.

Splenomegaly may be due to microörganisms, especially to those which reach the spleen in the course of acute or subacute infections such as tonsillitis, sinusitis, osteomyelitis. Tuberculosis is a well-known cause of splenomegaly, as is malaria, but in splenomegaly due to any of these causes

either the organism can be isolated or the microscopic appearance is pathognomonic. No such organisms could be isolated in this case nor, as is shown by the varying reports by pathologists, was there a pathognomonic appearance of the spleen. In every case of splenomegaly of known etiology, characteristic changes are present, but no such changes were demonstrable in this case. The function of the spleen in the production of anemia and of leukemia is not known except that the enlarged spleen has a destructive effect upon the red blood cells and a productive effect upon the white blood cells. In this case anemia was not present excepting for a brief period after operation nor was leukemia manifested at any time. In fact, as far as we have been able to discover, no case of splenomegaly has been reported in the literature in which the aleukemia has been as marked as in this case. Nevertheless, it may be noted that the microscopical appearance of the spleen suggested to one of the pathologists that we were dealing with splenomyelogenous leukemia.

The röntgenographic appearance of the lungs together with the positive von Pirquet test would suggest that this was a case of tuberculous splenomegaly; but this again is apparently ruled out by the microscopic findings.

Uncertain though the pathology in this case may be, nevertheless the fact remains that in every case of splenomegaly there must be some definite etiological factor. In this case the true cause may be disclosed at a later date, perhaps only at autopsy. The blood picture, that is the increasing percentage of lymphocytes, suggests, however, that the patient may come back presenting a true clinical picture of lymphatic leukemia. Whatever the final outcome may be, it seems worth while to report this case in the hope that together with the reports of other cases, the pathology of which is similarly uncertain, it may at some time aid in throwing some light upon the function of this still mysterious portion of the mysterious reticulo-endothelial system.

A REVIEW OF 500 SPLENECTOMIES WITH SPECIAL REFERENCE TO MORTALITY AND END RESULTS *

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It is my purpose in this paper to evaluate briefly our experience in the clinic in those dyscrasias which have led to the removal of the spleen, and to comment in general on what may be expected from splenectomy as borne out by the statistics.

I have grouped the cases under four headings, having in mind the clinical rather than the pathologic aspects; necessarily such grouping is only approximate: (1) diseases associated with abnormality of the white blood cells and related structures; (2) diseases associated with changes in the red blood cells, and blood platelets; (3) diseases due to infectious and toxic agents, and (4) miscellaneous diseases. Giffin and his associates have made a study of the blood changes in these cases and have correlated them with the clinical picture, and MacCarty and his associates have studied the pathology of the removed spleens and in due time will present their findings.

FUNCTIONS OF THE SPLEEN

The spleen is a part of the reticulo-endothelial system, as described by Landau and Aschoff, which includes the lymphoid tissues and certain endothelial and connective tissues. It is a hemolymph gland and is probably most closely associated in function with Kupffer cells of the liver. The arteries of the spleen as they separate into smaller vessels lose their middle and outer coats in the parenchyma of the spleen, so that the endothelium of the capillaries is continuous with the endothelium of the sinuses. The blood of the capillaries therefore passes directly into the sinuses themselves. The splenic vein joins with the portal vein and carries about 20 per cent. of the volume of the portal circulation.

The functionally active cell of the spleen, which corresponds to the Kupffer cell of the liver, is a large mononuclear endothelial leukocyte which has an exceedingly efficient phagocytic action and plays an important part in removing bacteria from the blood, as in typhoid and tuberculosis, and protozoa, as in syphilis and malaria. The strainer function of the spleen is well exemplified in those splenomegalias in which the spleen is unable to deliver bacteria, protozoa, and toxic material with sufficient speed to the liver for destruction and detoxication. The retention of this deleterious material in the spleen may lead not only to splenic enlargement but to systemic reinfections, as is known to be the case in syphilis and certain forms of sepsis.

It is worthy of note that the large supply of well oxygenated arterial

blood carried by the splenic artery is converted into venous blood without exerting an adequate known function. This oxygen is evidently not lost in combustion for the purposes of heat and energy. The fact that oxygen is utilized in the spleen in large quantities necessarily means that some other substance is oxidized. There is little evidence and no logical reason for believing that de-oxygenation of the blood in itself is a function of the spleen, for a sufficient quantity of de-oxygenated blood is already supplied to the liver through the portal vein. The question of whether or not the oxidation is for the purpose of destruction of undesirable substances (detoxication theory) or for the purpose of elaborating some complex substance, (for example, the highly complex hæmoglobin protein molecule), offers an interesting field for investigation. It might also be suggested that these oxidized substances are prepared in the spleen for the purpose of further treatment by the liver.

The removal of the normal spleen in cases of traumatism in man, and its removal in experimental animals, does not seem to cause permanent abnormal disturbance. On removing the spleen one is struck by the enormous amount of venous blood which it contains. It has been shown by Barcroft and Stevens that in the dog about 20 per cent. of the total blood volume may be stored temporarily in the spleen. The spleen contains a considerable amount of nonstriated muscle tissue and is known to possess a certain rhythmic contraction comparable to that of the gastro-intestinal tract and the uterus. It may be assumed that in times of stress stored blood is impelled through the portal circulation into the general circulation by splenic contractions, which possibly account for the pain in the left side so often experienced by long-distance runners. It may also account for the tradition that the ancients removed the spleen of runners in preparation for the Marathon races.

The spleen has some connection with the sympathetic nervous system through scanty fibres to the capsule, but it would appear to act largely through the influence of certain hormones which as yet have not been identified.

Normally the spleen probably does not produce white blood cells in the adult; this function or dysfunction of the spleen is apparent in splenomyelogenous leukemia.

Approximately 20 per cent. of the volume of the arterial blood is oxygen. When the red blood cells are reduced in number, suboxidation results. The relief which is sometimes manifest in the anemias on increasing the respiratory oxygen intake artificially may be due in part to correction of the suboxidation.

The embryonic red blood cells have dimly visible nuclei which disappear when the oxygen-bearing function becomes established. Since the adult red cells do not have nuclei they do not reproduce themselves, and must be replaced. The work of Ashby of The Mayo Foundation showed that red blood cells continue their oxygen-bearing function for at least six or seven weeks and probably longer. It should be noted that there are one or more atoms of iron to each molecule of hæmoglobin, showing the foundation for

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the improvement which sometimes follows the use of iron in the anemias.

The red blood cells and the blood platelets are formed in the bone marrow. The function of the spleen in destroying worn out red blood cells and blood platelets is an important one.

The experiments of Mann and his co-workers show that bile is not formed in large amounts in the liver, but that one of the functions of the liver is to filter bile from the blood. The destruction of the red blood-cells, which produce the pigments of the bile, is accomplished largely in the bone marrow (where also these cells and the blood platelets are formed), in the spleen, in the Kupffer cells, and, to a less extent, in the reticulo-endothelial tissues of the body generally.

In the removal by the spleen of worn out red blood cells and blood platelets from the blood-stream lies the explanation of increased function of the spleen in those specific splenic enlargements which accompany hæmolytic jaundice and hemorrhagic purpura, and one may surmise that although the splenomegaly in hæmolytic jaundice and hemorrhagic purpura may to some extent be a work hypertrophy, any enlargement of the spleen means distinct danger to the red blood cells, without regard to the nature of the enlargement, and probably will be accompanied by anemia.

In splenic anemia the red blood cells, and often the white blood cells, are reduced in number; the white cells not infrequently to 3,500 or below. In the late stages of this particular dyscrasia, the so-called Banti's syndrome of cirrhosis of the liver may occur, suggesting that diffuse irritating products are filtered from the blood-stream by the spleen or are formed in it. Failure of the liver to detoxicate these products leads to generalized hepatic fibrosis as the result of the attempt to encapsulate them. Just what these irritating substances may be is not known, but from our knowledge of the pepper and alcoholic cirrhoses originating in the gastro-intestinal tract we can surmise that they are chemical in nature. Giffin and Brown have shown recently that the blood volume is increased in cases of simple splenomegaly previous to the development of anemia; this indicates that there is an early factor in the disease which causes splenic enlargement with an increased circulatory bed.

I realize that this brief survey of the experimental and clinical fields is unsatisfactory and lacks greatly in detail, but at least it gives a perspective.

OPERATIVE EXPERIENCE

Between April 1, 1904 and March 1, 1928, splenectomy was performed in the clinic in 500 cases, with a mortality of 10 per cent. In speaking of the death rate, I refer to the deaths in the hospital. Many of the patients recovered from the operation, but for various reasons were not dismissed from the hospital and died there from causes other than the splenectomy. Eighty per cent. of the patients who recovered from the operation and are now living are in good condition, and the ultimate results are even more satisfactory than a cursory examination of the statistics might lead one to believe. As Bloodgood has pointed out in connection with a follow-up of patients operated

on for cancer: "Whereas bad news travels quickly, those patients who are difficult to trace, when heard from usually prove to be well." Further, we assume that all deaths in a series of cases occur from the disease, but it is only just to consider the natural death rate in a period of twenty-four years.

GROUP I.—*Diseases Associated with Abnormality of the White Blood Cells and Related Structures.*—Splenectomy was peformed in fifty-four cases because of abnormal changes in the white blood cells and related structures, associated with enlargement of the spleen.

	Patients	Hospital mortality
Splenomyelogenous leukemia	45	3
Lymphocytic splenomegaly	8	
Hodgkin's disease	1	

Splenomyelogenous Leukemia.—In forty-five cases of splenectomy for splenomyelogenous leukemia there were three deaths in the hospital. Splenomyelogenous leukemia has been looked on as an incurable disease, and superficially it would appear that there was little excuse for removing the spleen. However, if we consider first that what we call splenomyelogenous leukemia may be a terminal stage of various types of blood dyscrasias which are recognized only when they have reached a fatal stage, perhaps to a certain extent we are naming a prognosis rather than the actual disease. Splenectomy is suggested in these cases by the fact that any treatment which reduces the size of the spleen improves the condition of the blood and thereby the condition of the patient.

Patients in this group have lived and have been able to work for a number of years after splenectomy. At no time has the blood become normal, but great, and, in some instances, prolonged palliation has resulted. The results are better than they appear, because in cases of possible splenomyelogenous leukemia, when the condition of the blood approaches normal after splenectomy, it is assumed that the disease was not true splenomyelogenous leukemia, and the case is classified with the splenic anemias or is left unclassified. These cases will be explained later in the light of future knowledge.

It has been found that by reducing the size of the leukemic spleen either with X-ray or radium preliminary to operation, the spleen can be removed with not to exceed 5 per cent. mortality. In younger and middle-aged patients in the early stages of this apparently hopeless condition, the merits of splenectomy should be considered.

Lymphocytic Splenomegaly.—Splenectomy was performed in eight cases of lymphocytic splenomegaly with no deaths. These cases are closely related to the cases of generalized lymphosarcoma, and possibly also to lymphatic leukemia on the one hand and to Hodgkin's disease on the other. They vary greatly in the degree of malignancy. Half of them apparently have been of a benign type and the patients are living from one to six years after operation.

Hodgkin's Disease.—The spleen was removed in one case for a curious

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condition which was classified temporarily as localized Hodgkin's disease. The classification of this case awaits further knowledge.

GROUP 2.—*Diseases Associated with Abnormality of the Red Blood Cells (and Blood Platelets)*.—Splenectomy was performed in 330 cases for enlarged spleen associated with abnormality of the red blood cells.

	Patients	Hospital mortality
Splenic anemia	140	15
Hæmolytic jaundice	88	4
Hemorrhagic purpura	27	1
Pernicious anemia	62	4
Polycythemia vera	3	1
Indeterminate hemorrhagic disease	4	
Acute aplastic anemia	2	
Chronic aplastic anemia	2	
Chronic hæmolytic anemia	1	
Indeterminate congenital jaundice	1	

Splenic Anemia.—Splenectomy for splenic anemia was performed in 140 cases. There were fifteen deaths in the hospital. More than half the patients are living, and all but six are in satisfactory condition. The hospital death rate in this group is high, but when it is considered that a goodly proportion of patients operated on were in the terminal stages with advanced cirrhosis of the liver, ascites, and œdema, and that many of these recovered and remained well for a term of years, the results are satisfactory, and demonstrate the remarkable power of the liver to regenerate. This encouraging showing, however, led to operation in many cases in which conditions were such that the risks, although justified, were great. Ten per cent. of the patients who died during the ten year period after splenectomy for splenic anemia died from gastric hemorrhage. It is assumed that bleeding was due to varices in the lower part of the œsophagus and around the cardia of the stomach.

Hæmolytic Jaundice.—Splenectomy was performed in eighty-eight cases of hæmolytic jaundice, with four deaths in the hospital. Eighty-one of the patients have been traced. Seventy-three are known to be living, of whom seventy-two are in good condition. Splenectomy in hæmolytic jaundice stands out as a life-saving operation. It was first used in the clinic in 1911, and our interest in the procedure was given further impetus by the publication in 1915 by Elliott and Kanavel of their splendid contribution on the value of the operation in hæmolytic jaundice.

Hemorrhagic Purpura.—Splenectomy was performed in twenty-seven cases of hemorrhagic purpura, with one death in the hospital. Twenty-six patients are living and in good condition. Here again is a triumph for splenectomy. It is most important to make a correct diagnosis before coming to a decision concerning surgical treatment. Acute aplastic anemia especially simulates hemorrhagic purpura, and differentiation of the two may at times be very difficult.

Pernicious Anemia.—The modern treatment of pernicious anemia by a diet containing liver and high in vitamines has at least temporarily replaced splenectomy. Splenectomy was performed in sixty-two cases of pernicious anemia, with four deaths in the hospital. Three of these deaths occurred in the first nineteen cases, in which the operation seemed justified only in the late stages of the disease. Splenectomy should be performed, if at all, only when the patient is on the upgrade following transfusions and other methods of rehabilitation. The temporary improvement which followed removal of the spleen was marked in practically every case, and the prolongation of life in 25 per cent. of the cases was about two and a half times the life expectancy if splenectomy had not been performed. None of the patients was considered cured, for if apparent cure resulted, the case was placed in a different classification since probably it was not true pernicious anemia. I think every case should be carefully considered on its merits in order to detect the occasional doubtful case in which splenectomy may be advisable. There is a group of cases in which there is achlorhydria and what seems at the time to be secondary anemia in which the other features of pernicious anemia have not developed; in these splenectomy might logically be considered if the spleen is enlarged.

Polycythemia Vera.—Splenectomy was performed in three cases of polycythemia vera, with one death. The results in the two cases were extraordinarily good. While the patients are not well, they have been able to work for several years.

GROUP 3.—*Diseases Due to Infectious and Toxic Agents.*—In the group of splenomegalies in which the spleen acts as a filter and removes microorganisms and toxic agents, splenectomy has a field of usefulness. The enlarged spleen was removed in eighty-six cases in this group.

	Patients	Hospital mortality
Tuberculosis of spleen	9	1
Syphilitic splenomegaly	10	1
Acute, subacute and chronic septic splenomegaly	30	7
Portal cirrhosis	37	7

Tuberculosis of the Spleen.—In nine cases in which the tuberculosis appeared to be confined to the spleen, seven patients have remained well over a long period of years since splenectomy. One patient died of generalized miliary tuberculosis which came on immediately after operation, possibly due to direct venous contamination in the course of the operation.

Syphilitic Splenomegaly.—There were ten cases of splenectomy for syphilitic splenomegaly, with one death in the hospital. These patients all had advanced anemia, large spleens, secondary gummata in the liver, and were unable to maintain a negative phase under antisyphilitc treatment carried on for months. The removal of the spleens, which in some instances were found to contain spirochetes and small gummata, was followed by rapid recovery.

The improvement in these resistant cases following splenectomy and subsequent treatment amounted to cure.

Septic Splenomegalies.—The septic splenomegalies are unsatisfactory cases for operation. In the thirty acute, subacute, and chronic cases in which splenectomy was performed, there were seven deaths. In the more acute cases in which bacteria were cultivated from the blood, the results were poor, and it probably would have been wise to delay the operation until a greater degree of natural immunity had been established. In the cases in which septic endocarditis was present at the time of the splenectomy, there were no cures. In the chronic cases the results were much better; where natural immunity had been established the results were good, and the risk small.

Portal Cirrhosis.—The results of splenectomy in the Banti stage of splenic anemia for the relief of cirrhosis of the liver were so extraordinarily good as to lead to the removal of the spleen in thirty-seven cases of cirrhosis of the liver in which the spleen was only moderately enlarged. The operation was performed late in the history of the disease which was evidently of gastro-intestinal origin. There were seven deaths in the hospital in this series. Although there were brilliant exceptions, the results in these cases on the whole were only fair, not better than in a comparable group of cases in which some type of Talma-Morison operation had been performed with less risk.

GROUP 4.—*Miscellaneous Conditions.*—Splenectomy was performed in thirty-one cases for miscellaneous conditions.

	Patients	Hospital mortality
Gaucher's disease	7	2
Ruptured spleen	4	1
Wandering spleen	2	
Hemorrhagic cyst	2	
Multiple serositis (Pick's disease)	1	1
Eosinophilia with splenomegaly	1	
Neutrophilia with splenomegaly	1	1
Hemangioma	1	
Condition necessitating secondary splenectomy	9	
Unclassified	3	1

Gaucher's Disease.—Splenectomy was performed seven times for Gaucher's disease. The five patients who lived were greatly improved and, although they were not cured, were able to work and earn a living.

Time does not permit me to discuss further this interesting group of cases, which I have tabulated merely for general information.

ABSCESS OF THE SPLEEN

By Arthur E. Billings, M.D.

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Abscess of the spleen is an unusual and very interesting condition clinically, but not so rare as one is led to believe by the number of reported cases in the literature. The more notable earlier papers on the subject are those of Grand-Moursel, who collected fifty-seven cases in 1885, Esau's report of seventeen cases of typhoid abscess in 1903, and Kuttner's collection of one hundred and sixteen cases in 1907. Elting, in a very able paper read before this association in 1915, covered the subject admirably and added the report of his own case. Since then other important contributions on various phases of splenic suppuration are those of W. J. Mayo, Balfour, Cutler, Inlow, A. F. Wallace, Lenormant et Seneque, Morel, Dambrie et Tapie, Merklen, Froelich and Stulz, Sabrazes, Pauzat and Laubie, Montel, Kreke, and Krumbhaar.

We are presenting the report of three cases of abscess of the spleen operated upon with recovery, the first that of Dr. John H. Jopson and the second that of a colleague, Dr. Edward J. Klopp, to both of whom I am indebted for the privilege of including their case reports in this paper. The third case is a personal observation.

Case I.—Doctor Jopson's case report. Female, white, age twenty-six years, Jewish, six children. Puerperal sepsis in August, 1926, following birth of her last child. Treated in another hospital for this condition. Bears scars of several incisions on extremities, where abscesses were opened. Evidently had a septicæmia at this time. Admitted to the Presbyterian Hospital, November, 1926. Chief complaint, pain in left upper abdomen. Patient was emaciated, running a moderate temperature, 99–100, secondary anemia, white blood count 16,000. Smooth, rounded swelling in the left hypochondrium, diagnosed as enlarged spleen. X-ray and physical examination, a moderate amount of fluid in the left pleura. No marked elevation of diaphragm on either side. Pelvic examination, thickening of broad ligaments. This most marked on left. Urine examination, moderate number of white cells. Blood culture sterile. Operation through left rectus incision. Pus evacuated immediately beneath costal margin. It contained thick, yellow pus, which was sterile on culture. The walls were ragged and sloughing. Diagnosis, abscess of the spleen, with perforation of the capsule. Abscess cavity drained. Gradual improvement. Prolonged convalescence, with one or two periods of prolonged elevation of temperature, without a definite cause. Left pleural cavity cleared. Discharged from hospital five months later with a sinus still draining. Admitted five months later with an unclosed sinus, and X-ray examination showed a small collection in the left subphrenic region. Reoperation. Excision of sinus opening, extension of incision upward to costal margin, counter incision in the tenth interspace, mid-axillary line, and drainage of subphrenic abscess. Complete healing followed this procedure.

Doctor Jopson regards this case as splenic abscess, probably in the lower pole, following puerperal sepsis, with perforation of capsule and secondary collection in subphrenic area and left hypochondrium. The interesting features are (a) the etiology, (b) the sterility of the abscess when drained, (c) the association of subphrenic abscess. All these features of course have been well recognized as present in a certain percentage of cases, greater or lesser, of splenic abscess.

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CASE II.—A woman fifty-seven years of age entered Jefferson Hospital, September 19, 1923, complaining of abdominal pain and difficulty on urination. She had scarlet fever, measles, and chicken-pox during early childhood, menstruated first at the age of nine and passed the menopause at forty-nine. Her menstrual life was somewhat irregular and during the latter part of it the flow was more profuse than normal. She gave birth to one child at the age of thirty-two. There is no history of miscarriages or pelvic infection. For many years she has suffered from flatulent indigestion and has always been constipated. She thinks her present trouble began three years ago with headache, loss of appetite and soreness in the abdomen. One year ago she had an acute abdominal attack of indefinite character lasting three days. She complains of feeling a tumor in the lower abdomen which interferes with urination. During the last six months her condition has grown worse, characterized by fever, increasing weakness and soreness in the abdomen. Physical examination reveals a very large and excessively fat pallid individual. Her teeth are in very bad condition. The lungs are clear, but there is a loud systolic murmur heard best over the apex of the heart. There is œdema of both feet and ankles. The abdomen is distended and there is felt a tender rounded mass in the left upper quadrant extending under the left costal margin, and another mass in the lower abdomen, which, on bimanual

FIG. 1.—A tumor which corresponds in position and shape to an enlarged spleen and which is tympanitic on percussion is pathognomonic of this variety of splenic abscess. (Wallace.)

examination feels like a uterine fibroid. General examination is otherwise negative. Temperature on admission was 100. Moderate irregular fever, not higher than 102, continued for eight days after which it was normal. Pulse rate varied from 80 to 110. During the first forty-eight hours of her stay in the hospital she had three chills. Examination of the blood showed a secondary anæmia, hæmoglobin 69 per cent., red blood cells 4,888,000. The leucocyte count on admission was 38,400, color index 7, polymorphonuclears 86 per cent., small mononuclears 10 per cent., large mononuclears 2 per cent. Four days later the white blood count had dropped to 19,800. Several other white cell counts varied between the two noted. A blood culture remained sterile after four days. Repeated urinalysis showed a persistent cloud of albumin with occasional granular casts and pyuria (50 to 100 pus cells per high powered field). The X-ray study was made by Doctor Manges who reported as follows: "From the radiographs alone the evidence favors the mass being spleen. If you permit we would advise a gastro-intestinal meal so that we may tell by displaced organs the definite location of the lesion." The report

continues after the ingestion of the gastro-intestinal meal: "The mass in the left upper quadrant is of splenic origin. This seems clear both by the displacement of the splenic flexure of the colon and also the elevation of the left diaphragm. We are unable to tell the cause of the enlargement."

Operation October 3. The abdomen was opened through a left upper rectus incision under gas-oxygen anæsthesia. Before breaking into the inflamed mass in the splenic region, the general cavity was explored. Stones were found in the gall-bladder and a moderately large fibroid of the uterus was also found. The splenic area was then packed off with gauze and a number of dense adhesions about the anterior surface of the spleen and its lower pole were separated. The abscess in and about the spleen was then opened and about six ounces of pus evacuated. The cavity was drained with rubber covered gauze drains around which the incision was partially closed. Culture from the pus showed staphylococcus pyogenes aureus. The day after operation her temperature was 101.3, pulse 100. Temperature became normal on the third day after operation and the patient made an uneventful recovery. She was discharged from the hospital on the 28th of November. Cause of the abscess is obscure. Doctor Klopp feels that a probable source was the urinary tract infection.

FIG. 2.—The case on the left has been cured. The other is a case before operation. (Wallace.)

CASE III.—A man, white, thirty-five years of age, was admitted on October 29, 1926, to the Pennsylvania Hospital on the surgical service of Doctor Gibbon, to whom I am very grateful for the privilege of operating upon and reporting this case. He had typhoid fever at the age of ten and was operated upon for hemorrhoids four years ago. He suffered frequent attacks of tonsillitis until tonsils were removed three years ago. Two weeks before entering the hospital he developed a carbuncle on the back of his neck which was incised a week later. This improved and he felt better until two days before admission when he was suddenly seized with severe pain in the left hypochondrium radiating along the costal margin to the back, associated with fever, chills and sweats. There was no nausea or vomiting. Deep breathing, coughing and moving around in bed aggravated the pain which was continuous. He was not constipated and there were no symptoms referable to the genito-urinary tract. Physical examination reveals a recently incised healing carbuncle on the back of his neck. Respiratory movements were restricted particularly on the left side. Lung expansion was poor, there was slight suppression of breath sounds at the left base,

but nothing else abnormal was noted on percussion or auscultation of the chest. The abdomen was somewhat distended. There was marked muscular rigidity and tenderness in the upper left quadrant. A palpable, rounded, tender mass, presumably spleen, extending three or four centimetres below the left costal margin was present. This represented the most tender area. Tenderness, however, extended around the costal margin to the loin and back. There was a marked increase in the area of splenic dullness to percussion which provoked pain. The liver was palpable but not tender, peristalsis was nor-

mal and general examination was otherwise negative. Temperature was 101, pulse 104, respirations 20, leucocyte count 34,000, hæmoglobin 90, red cells 6,260,000. Diagnosis of abscess of the spleen was made by Doctor Parker, the chief resident physician.

On the day after admission, the leucocyte count was 42,600. (Polymorphonuclears 80 per cent., lymphocytes 17 per cent., mononuclears 2 per cent., eosinophils 1 per cent.) The temperature, however, was lower and for the next two weeks remained below 100 and near normal most of the time with a pulse rate of 80 to 90. There was a gradual reduction in leucocytosis to 12,000, and a diminution in the size of the mass with much less pain and tenderness. An apparent improvement in the patient's general condition led us to believe that the infection was subsiding and made us doubt the correctness of the admission diagnosis of abscess of the spleen. We were further convinced of this by our observation of the next ten days

FIG. 3.—Primitive, but effective method of drainage by stab wound and inserting of rubber tubing.

which carried us to his twenty-third day in the hospital and the twenty-fifth day of his illness. Our false sense of security was then much disturbed by recurrence of pain, increased fever (101) and leucocytosis of 33,000. (Polymorphonuclears 82 per cent., large lymphocytes 4, white lymphocytes 9, transitionals 2, large mononuclears 3.) At this time he developed a slight dry cough with a few râles and a definite friction rub in the lower left chest anteriorly. Repeated examinations had not revealed any abnormal findings in the urine, Wassermann reaction was negative, blood culture was sterile, blood chemistry was normal, (sugar 96, creatin 1.3, urea nitrogen 8.2). Culture of pus from the discharging carbuncle showed the presence of staphylococcus pyogenes aureus. October 26, the leucocyte count was 50,500. During the three or four days following this high leucocyte count there was a reduction in fever and leucocytosis to 21,000 with a lowering of the

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pulse rate and apparent improvement again in the patient's general condition. There was no evidence of further pleural or pulmonary involvement.

Operation was done December 3, under morphia, gas, oxygen anæsthesia. The abdomen was opened through a left upper rectus incision and the spleen, much enlarged, was found extending to the level of the umbilicus and surrounded by adhesions. Protecting the general cavity with gauze, the adhesions between the abdominal wall and surface of the spleen were partially separated and the abscess, which had ruptured through the capsule, was opened, discharging about 250 c.c. of reddish-yellow pus. This extended deeply into the splenic substance of the lower pole. A vaselinized gauze pack used as a drain, around which the wound was partially closed, controlled the slight bleeding from the walls of the abscess. The patient's condition was good at the conclusion of the operation and the temperature was normal four days later. The gauze pack was gradually removed and the wound discharged freely for about three weeks. Culture from pus showed staphylococcus pyogenes aureus in pure culture. The wound healed slowly but satisfactorily and he was dismissed from the hospital 58 days after operation. At this time leucocyte count was 11,500 and his blood picture, which has been followed with frequent examinations for more than a year since operation, failed to disclose any abnormalities in the character or number of platelets, white or red cells. The probable source of infection was the carbuncle, as the same type of organism was recovered from both suppurating foci. In retrospect

FIG. 4.—Showing elevation of left diaphragm before drainage of abscess.

we criticize our delay in surgical intervention, as the conditions were obvious from the standpoint of diagnosis and the indications were definite for early operation.

The causes of abscess of the spleen are numerous but its development depends almost invariably on the deposit by the blood-stream of pyogenic organisms from some primary source of infection. The source may be a suppurating focus, obvious or concealed in any part of the body. This is shown in the great variety of attributed causes in the reported cases. The condition most frequently occurs where there is a general blood-stream invasion by pus producing organisms, and the infection has reached the magnitude of a septico-pyemia such as is observed in the cases of acute ulcerative endocarditis and other virulent generalized infections most commonly caused by streptococci and staphylococci. Almost all of the pyogenic organisms are represented as causative agents.

W. D. Inlow, who in 1927 collected 23 cases of traumatic origin, report-ing one of his own, states that 15 per cent. are due to trauma. Many of the acute infectious diseases have been assigned as a cause of splenic suppuration, —influenza, small-pox, rheumatic fever, etc., while certain of the specific fevers play a special rôle in the etiology of abscess formation in the spleen. This is particularly true of enteric, and to a lesser extent of typhus and relapsing fevers. None of the recently reported cases have been attributed to malaria, which Kuttner and the earlier writers ranked next to typhoid. Chowdhooray noted the occurrence of three cases of abscess of the spleen in 30,000 cases of mala-ria. Kuttner reported in 1927 twenty-five instances supposedly due to malaria and since then three cases of malarial origin have been recorded. Nearly all resulting from malaria were observed in India, Italy and South Africa. Typhoid, which is accred-ited by various authors, (Kuttner, Morel, Sa-

FIG. 5.—Elevation of left diaphragm less marked, about two weeks after operation.

brazes) as causing about 14 per cent. of the cases, and acute vegetative endo-carditis, are undoubtedly the most common single causes. Merklen reported a case due to para-typhoid infection. Montel's case was due to an atypical para-typhoid bacillus, both terminating fatally.

In a review of 3600 autopsies at the Pennsylvania Hospital we found twenty-four instances of abscess of the spleen, thirteen in males and eleven in females of an average age of twenty-eight years. An ante-mortem diagnosis of abscess of the spleen had not been recorded in any case and in nine instances abscess was found associated with acute ulcerative endocarditis. These cannot be regarded with great importance from a surgical standpoint as in none of them were there any symptoms or signs recorded, prior to death, which would have led to or even suggested a diagnosis of abscess of the spleen. Furthermore, whether or not recognized, it is a late complica-tion of a malady in itself almost invariably fatal. In most of these cases, as in several of the others dying from various causes, there was positive blood-stream infection and toxemia of such a marked degree that any significant localizing symptoms of splenic abscess probably would have been obscured.

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In nearly all of them multiple abscesses were found associated with abscesses of the same character in liver, kidneys and lungs.

In five cases abscess was found in association with acute peritonitis the result of streptococcic or staphylococcic pelvic infection. In three, the abscesses were multiple, in the other two they were small and solitary and in none were there any symptoms recorded suggestive of splenic inflammation. It was noted in three of these cases that there was no tenderness or enlargement of the spleen found on examination shortly before death.

Abscesses occurred in three of the subjects as a complication of typhoid fever and these are more interesting from a surgical standpoint than those already considered.

FIG. 6.—Left diaphragm about normal one year after operation.

One patient had been ill for six weeks when he was admitted to the hospital in a typical typhoid state with a positive blood culture, a positive widal reaction and 3,100 leucocytes, but apparently doing well. On entering the hospital there was present a to and fro friction rub at the left base below the eighth rib. There was also noted dullness on percussion over this area, but no abdominal symptoms were recorded. Temperature elevation continued 101–103 for three weeks, signs in left chest persisted, but lessened as the temperature became normal and convalescence was seemingly well established for fifteen days when the patient suddenly died while sitting up on a back rest. Autopsy showed an abscess of the spleen with a sub-diaphragmatic abscess and dilatation of right ventricle and auricle as the probable immediate cause of death.

Another patient was admitted on the fifth day of his typhoid infection with a positive widal, a negative blood culture and leucocyte count of 3,800 and severe toxemia. Temperature was about normal on the 23rd day of the disease and remained so for about a week when it became elevated, irregular and associated with chills, sweats and signs of pleurisy and accumulation of fluid in the left chest with a leucocyte count of 19,900. Prior to this a few râles had been heard on both sides. Two days later the left pleural cavity was aspirated and 200 c.c. of reddish-brown fluid was withdrawn. A thoracotomy with rib resection and drainage of the pleura was done. A considerable quantity of reddish-brown purulent fluid escaped. The abdomen was not distended and not tender. The patient succumbed two days later. Autopsy revealed an abscess of the spleen, an abscess of the left lung and necrosis of the left diaphragm. Culture from the abscess cavity showed typhoid bacilli.

The third case concerns a man who had been ill for five weeks before entering the hospital and it was thought he was suffering from a relapse of typhoid. On the day

before admission he was suddenly seized with acute abdominal pain and vomiting. He was admitted in a state of shock, his extremities were cold and his pulse barely perceptible. He had two very small hemorrhages from the bowel shortly after admission. The abdomen was fairly soft and the abdominal muscles were well moved in respiration, especially in the upper half. The spleen was not palpable or tender. Heart sounds were clear but weak, breath sounds were exaggerated over the left base. The patient hiccoughed and had violent paroxysmal contractions which resulted in vomiting at five minute intervals. The vomitus had a fecal odor. Widal reaction was suggestive and leucocyte count was 34,800. On the day after admission an exploratory abdominal section was done and the findings recorded were as follows: "no peritonitis found, the appendix, gall-bladder, pancreas, liver and spleen felt normal, no distention of the organs, color of the intestines was good and there was no obstruction. The abdomen was closed. The patient died four and a half hours later." Autopsy revealed acute phlegmonous gastritis with exudate in the duodenum and ilium, healing typhoid ulcers in the ilium, abscess of the spleen and thrombosis of the aorta at its bifurcation.

Suppurative appendicitis was the antecedent infection in two cases. In one instance a girl of fourteen was admitted and operated upon three days after the onset of an acute suppurative appendicitis with peritonitis. The appendix was removed and drainage established. Four days later there were signs of a left basal pleurisy and extending peritoneal infection. Death occurred ten days after operation. Autopsy revealed acute generalized peritonitis, multiple abscesses of kidneys and spleen. (Several scattered throughout its substance.)

In contrast to this example of pyemic multiple abscess formation, a part of a terminal infection, the other case followed more than a year after a drainage operation for appendicitis, where there was a persistent sinus until shortly before the sudden onset of the fatal illness. It was characterized by sharp low precordial pain aggravated by sneezing and coughing with the development of a left basal pleurisy. Spleen was enlarged to percussion and there was marked tenderness in the splenic area. Illness was progressive with chills and fever which was fluctuating and high (103–104). A pleural effusion was present and 400 c.c. of fluid was aspirated. A diphtheroid bacillus was grown on culture from fluid aspirated. Wassermann negative, blood culture negative, leucocytes 11,000 to 12,000. Autopsy disclosed chronic abscess of the spleen with sub-diaphragmatic abscess, peritonitis, multiple abscesses of the liver, pleurisy and atelectasis of base of left lung.

The other cases represent various etiological factors; one resulted from a staphylococcus pyogenes aureus infection of the upper lip with septicæmia; one followed suppurative cholecystitis with liver abscess. In another instance a large abdominal abscess in the lower left quadrant, supposedly resulting from diverticulitis or cancer of the sigmoid, was incised and drained. The patient improved, left the hospital with a discharging sinus but was later readmitted and the condition diagnosed clinically as cancer with metastasis to lungs as shown by X-ray examination. The terminal illness was of a septic character associated with chills, sweats and fever of an irregular type. The entire process, as shown at autopsy was due to actinomycotic infection, resulting in extensive invasion of lungs, liver and spleen in which there were

large areas of necrosis with central abscess formation. All organs showed typical bluish black pigmentation so often seen in actinomycotic infection.

In still another case we have an example of infection of the spleen with abscess formation by propagation, the result of perforation of the stomach. A large abscess had formed in the under surface of the spleen and adjacent to the greater curvature near the cardia which was the site of an ulcerating cancer.

In the last case the source of infection was not determined or even suggested by the history. The patient on admission was regarded as a case of generalized peritonitis too ill for operation. Tenderness and pain was most marked in the left hypochondriac region. There were signs of a left basal pleuro-pulmonary involvement and a loud to and fro friction rub was heard over the lower left chest anteriorly. At autopsy there was found a splenic and peri-splenic abscess which had ruptured resulting in peritonitis. Multiple abscesses were also present in the liver. Culture from the abscess of the spleen showed colon bacillus and streptococci. Twenty years before he had had typhoid fever.

Infarction of the spleen was found in 141 instances of the 3,600 autopsies. Two hundred and five of the examinations were done on subjects dead of typhoid fever. Nineteen showed infarction of the spleen and in three others abscesses were found from which typhoid bacilli were recovered.

Krumbhaar, in a study of 5,000 postmortem examinations, found thirteen cases of abscess of the spleen and splenic infarction in 202 instances. Certainly any acute infection, carrying with it a high incidence of infarction, as noted in some of the aforementioned specific fevers, where there is a primary bacterial invasion of the spleen, also incurs an increased liability to splenic suppuration.

A. F. Wallace reported in 1922 a remarkable and unique experience from Broken Hill, Northern Rhodesia district, South Africa, where in the two preceding years he had seen forty-nine cases of abscess of the spleen, having operated upon nineteen of them. The other thirty were either not diagnosed until after death, or more usually, had died outside the hospital and their bodies were sent to the mortuary for examination. He had worked in this locality for twelve years without observing a case until the last two years of his service. He maintains the cause is obscure, but is inclined to look upon the infection, which frequently leads to thrombosis of the leg, mesenteric and cerebral veins, as some new disease or possibly a manifestation of influenza which is very prevalent and endemic among the natives, or a peculiar type of relapsing fever. The only organism reported is a spore bearing, gas producing bacillus. In these cases the onset is sudden with high temperature, headache and distributed pains in the neck and body. General symptoms usually subside in three or four days followed by pain in the spleen which rapidly enlarges and becomes tender. Operation reveals a large abscess filled with chocolate brown pus and foul smelling gas. He has drained nineteen cases through vertical abdominal incision with fifteen recoveries.

In a personal communication from Doctor Wallace dated April 13, 1928, he makes the following statements concerning his series of cases, a part of which was previously reported in the *South African Medical Journal:*

"Altogether I have either operated on or found at postmortem well over one hundred cases of splenic abscess all similar to those described. No further clue has been found as to their etiology. A Belgian doctor in the Congo, (north of here,) published a series of four cases identical with mine, so the abscesses are not purely local. My opinion is that there is a disease endemic in Broken Hill which resembles influenza. A complication of this disease is thrombosis. This occurs in order of frequency in

(1) Leg veins leading to leg œdema.

(2) In the spleen leading to infarction, and if this infarction becomes secondarily infected with gas-forming organisms from the intestine a splenic abscess of our local variety develops.

(3) Thrombosis of the axillary veins with œdema of arm.

(4) Cerebral thrombosis.

(5) Thrombosis of the cavernous sinus.

(6) Thrombosis of the mesenteric veins.

The thrombosis is a venous one. There is never any sign of endocarditis postmortem."

Elting maintains that most abscesses of the spleen result from the breaking down of infected infarcts. This seems to have been the mode of development most frequently noted in the Pennsylvania Hospital series, and in several instances where multiple abscesses were present, other infarcts were observed in various early stages of suppuration. This process of degeneration or sphacelic separation of the infarct explains, according to most authorities, the occurrence of the "sequestrating abscess" described by Kuttner, where fragments of spleen of variable size are cast loose into the abscess cavity. This type, according to Kuttner, represents about 37 per cent. of all abscesses of the spleen. It appears in an autopsy series that multiple abscesses are more frequently found than the solitary variety which are larger and usually more deeply situated. Krumbhaar found multiple abscesses in ten of his thirteen cases, we noted fifteen in twenty-four instances. Clinically a single abscess is usually found.

The symptoms of abscess of the spleen are exceedingly variable in character and intensity. In some instances the manifestations that might be considered more or less typical are overshadowed or altogether obscured by the associated infection of which suppuration in the spleen is only a complication. Its course may be acute, subacute or chronic and the symptoms will be more or less pronounced accordingly, depending somewhat upon the etiological factor. Of the causes, typhoid fever probably influences more strikingly the course and character of symptoms than any other infection. In some instances abscess may develop during or follow closely upon the primary infection. More commonly there is an interval of a few weeks or months before suppuration takes place. It is sometimes mistaken for a

relapse. In exceptional cases, the signs of abscess formation may not be manifested for many months or years after the attack of typhoid. In Abadie's case it was twenty months, in that of Stulz, five years. Brown's case was even more singular. A girl had an attack of typhoid at the age of twelve after which she suffered intermittent pains in the splenic region, dying at the age of thirty-one from an enormous abscess of the spleen which had ruptured into the colon.

Local symptoms may be so mild as to be overlooked. Fauntleroy and Propping reported absence of pain in their cases. In other instances the symptoms are very pronounced from the beginning. In the more severe pyemic infections, the development of an abscess in the spleen may add little or nothing to the picture of a condition in itself probably fatal.

Abscess deeply situated and not involving the capsule will produce little or no pain and its development may only be accompanied by the general symptoms of suppuration, such as septic fever, chills, sweats and leucocytosis. As the evolution of the abscess progresses from the upper pole toward the thorax, or from the lower pole toward the general peritoneum, symptoms of a pleuro-pulmonary or abdominal nature will develop. When its extension is toward the thorax there will be diaphragmatic and pleural involvement characterized by pain of varying intensity, located in the left hypochondrium and lower thorax, radiating to the back and sometimes to the left shoulder. The signs at first are those of a dry left basal pleurisy which may culminate in a serous, hemorrhagic, or purulent effusion. This may be due to rupture of the abscess through the diaphragm. When empyema is a complication, its cause, abscess of the spleen, may not be revealed until necropsy.

Rupture into a bronchus has been reported. Abscess formation in the anterior surface or lower pole will give rise to symptoms of an abdominal character. If the abscess is walled off, the symptoms may be localized and confined to the upper left quadrant, characterized by pain, tenderness, muscular rigidity and signs of splenic enlargement with or without nausea and vomiting; otherwise a generalized peritonitis may rapidly ensue. The spleen is always enlarged and the degree of enlargement will depend upon the extent of the inflammation. In several of the reported cases the abscess has pointed in the loin. Rupture has taken place into the stomach and colon and a fecal fistula has been established through the thorax.

The signs and symptoms upon which one must depend for diagnosis are fickle. Frequently the condition is not recognized until autopsy because of its inconstant clinical manifestations. Pain, of varying intensity, is nearly always present. Fever may be moderate, continuous or intermittent, is sometimes absent, but is usually suggestive of suppuration and in the severe cases is characterized by marked remissions associated with chills and sweats. Leucocytosis may be absent, is usually higher than in most suppurative conditions and may exceed 50,000. Marked emaciation has been emphasized in several of the reports.

Enlargement of the spleen is of diagnostic value only in conjunction with

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other symptoms of suppuration. X-ray examination is of great diagnostic value. Elevation and fixation of the left diaphragm is very suggestive and is a constant finding where the infection has extended to the subphrenic space, as is usually the case in abscess of the upper pole. A chronic abscess may be shown and the spleen can be outlined after the administration of a gastro-intestinal meal by displacement of other organs. Exploratory puncture is a valuable aid to diagnosis and may give the needed information in a doubtful case. It has been condemned by a few, but is advocated by most writers.

The surgical treatment of abscess of the spleen is either splenotomy or splenectomy. In a review of the cases treated surgically, one finds that in the greatest number the procedure employed was splenotomy. Surgical approach to the abscess, as pointed out by Elting, may be gained through one of three routes: (1) trans-pleural, (2) abdominal, (3) retro-peritoneal. The avenue chosen will depend upon the direction of the abscess invasion, which is often toward the thorax and will indicate trans-pleural or trans-diaphragmatic approach. Abscess situated in the anterior surface or lower pole, will usually be more accessible through the abdomen. In exceptional instances pointing may take place in the loin, when access through the retro-peritoneal channel is preferable.

Finkelstein, in 1910, collected statistics for sixty-one splenotomies, with forty-eight recoveries and thirteen deaths, and eleven splenectomies with eight recoveries and three deaths.

With Lenormant et Seneque's group of twenty-seven cases reported in 1923, we have assembled twenty-eight other cases since 1907 including our own, which arrange themselves in the following order:

	Recoveries	Deaths	Total
Splenotomy	44	7	51
Avenue of approach:			
Thoracic	13	2	15
Abdominal	29	5	34
Retro-peritoneal	2	0	2
Splenectomy	1	3	4

The operative mortality in the traumatic abscess according to Inlow is 38 per cent. Abscesses of typhoid origin give the best prognosis. Morel, Dambrie and Tapie collected thirteen typhoid cases with twelve recoveries (splenotomies) and one death (splenectomy.) The outlook, so far as it concerns prognosis and treatment, will be regarded from the standpoint of the abscess and the condition with which it is associated.

Splenectomy, it would seem, is only indicated in rather exceptional instances where the organ is comparatively free from adhesions, the infection confined within its capsule and where removal can be effected without difficulty or danger of disseminating the infection. Usually by the time a diagnosis has been established, or surgical intervention practiced, the inflammation has already extended to adjacent structures causing secondary abscess formation and adhesions of a most formidable nature. Such a situation,

which is the rule, would render splenectomy a most difficult and dangerous procedure and splenotomy the easiest and safest operation.

I am very grateful to Dr. Wallace for the personal communication regarding his remarkable series of cases and for the photographs of patients before and after operation illustrating their appearance and his method of drainage.

For the use of the autopsy and case records in this report, we wish to acknowledge our gratitude to Doctor Paul and the Medical and Surgical Staffs of the Pennsylvania Hospital.

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SPLENECTOMY IN EGYPT

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David I. Macht, a graduate of the Johns Hopkins Medical School, and not only a well-known bio-chemist, but a scholar and student of Hebrew, sent me a very interesting reprint as a reminiscence of Dr. William J. Mayo's address before the students of the Johns Hopkins Medical School in January. Without doubt many of you are unfamiliar as I was that in ancient days spleens were extirpated in order to produce more fleet runners. Macht *— (Sonderdruck Aus Der Paul Haupt Festschrift, Leipzig, 1926, Vol. 1, J. C. Hinrichsche Buchhandlung)—in the study of the Talmud in two places finds passages which suggest that the runners were all of them deprived of their spleen in order that they might run more efficiently. In a second place it is noted that the swift steeds are also described as having had their spleens extirpated in order that they might run the better.

Macht also states that a study of ancient and modern literature finds references concerning the relation of the spleen to running. In the Natural History of Pliny it is stated that runners in the race that are troubled with spleen have a device to burn and waste it with a hot iron. In Arabic literature there is the same—that a horse runs better without a spleen.

Splenomegaly in Egypt.—When I was in Egypt in the early days of my medical career in 1893, I visited the great Government Hospital almost daily for ten days while I was in Cairo.

I was present at a number of autopsies and the portal vein was always opened as a routine to allow microscopic studies for bilharzia, which is probably a most common parasitic infection in this parasite-ridden country but I have no recollection of the condition of the spleens at these autopsies. Nothing then was known of the cause and cure of this infection. It was ravishing the Egyptians to the same extent the hook worm was infecting the people of the South in this country.

When I returned to Egypt in 1924, thirty-one years later, the cause and cure of this and other parasitic diseases had been well established. I witnessed in one day hundreds of Egyptians receive intravenous antimony which had been used in practice about three years. I found that in the Government Hospital and in the Christian Mission Hospital in Old Cairo there averaged about forty splenectomies more or less every year in each hospital. I learned

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* Macht: [The Effect of Splenectomy on Integration of Muscular Movements in the Rat. (Reprinted from the *American Journal of Physiology,* vol. lxii, No. 3, November, 1922, p. 525.)] made a series of experiments on rats, and noticed the difference between the splenectomized animals and the controls as they ran over a tight rope. The removal of the spleen did not interfere with the coördination of the muscles and the running of the animals. On the contrary it apparently improved the running speed.

that the operation was done under spinal anæsthesia, that the mortality was relatively low, and that when the patients recovered they were fully restored to their ability to work, not only because they had been relieved of the weight and pressure of the huge spleen in their abdominal cavities, but through medication, many different kinds of parasites and infecting organisms present in their tissues were destroyed.

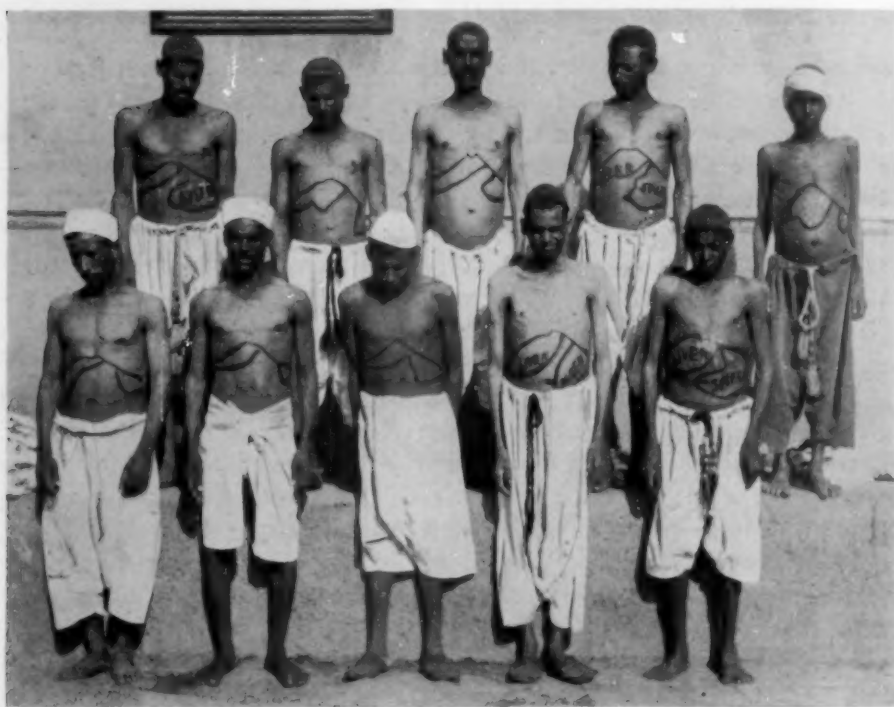I cannot go into details as to the remarkable relation between surgery

Fig. 1.—Photograph of a group of Egyptians with enlarged livers and spleens, outlined as they appear before operation.

in Egypt and the predominant diseases. If the annual splenectomies are forty in a great hospital, the yearly appendectomies are three, and there is not one operation upon the gall-bladder or for duodenal ulcer in a year. Conditions due to over-burdening and over-work are the most common surgical conditions in Egypt—hemorrhoids, hernia, and varicose veins. Next to this ranks splenomegaly due to the heavy parasitic infections present in the inhabitants of the land of the Nile. According to all authorities bilharziasis and ankylostomiasis are present in 75 per cent. of the inhabitants. Pellagra is very common, and one must always be on the lookout for syphilis. The malarial spleen is rare. Sir William Wilcocks, K.C.M.G., in a reprint printed at the Nile Mission Press in Cairo in December, 1927, considers why cultivated Egypt is immune from malaria. The practical point is that Egypt above the Delta is immune from malaria, and even in the Delta it is not so common under certain conditions.

When this subject was chosen for the chief topic at this meeting of the American Surgical Association I immediately wrote to a number of surgeons whom I had met in Cairo to get data. Just as answers were received I had the good fortune to be visited by Mr. H. E. Stiven, principal medical officer of the Egyptian Government at Port Said, who had with him his paper soon to be delivered on Splenectomy for Egyptian Splenomegaly, and this young surgeon has had the remarkable experience of two hundred and eighty-five

FIG. 2.—Three Egyptians back at work on sugar cane after successful splenectomy.

cases in six years, which would be about forty-six cases a year and corresponds with the annual number of removal of spleens in the two larger hospitals in Cairo. At the same time I received a letter from Dr. Robert Dolbey who for a number of years was professor of surgery in the Government Hospital at Cairo, so he is very familiar with the details of that operation as performed by the English and Egyptian surgeons. Then there is a full report from Dr. J. E. Bateman, chief surgeon and operator of the Christian Mission Hospital in Old Cairo. These three papers, giving complete data

of the three largest hospitals in Egypt, allow me to give you a brief picture of their results and their methods. There seems no question that the surgeons in Egypt are having the largest experience annually except, perhaps, in the Mayo clinic, and apparently they are dealing with a type of individuals whose vitality is tremendously reduced, and a type of spleen very difficult to remove because of extensive adhesions.

The reports from other surgeons—English and Egyptian—in Egypt have not been received in time to incorporate them in this paper, nor am I able to give as I hoped a résumé of splenomegaly in oriental countries.

Pre-operative Preparation.— Dolbey, whose experience was in the Kasr el Ainy Government Hospital in Egypt, writes that they pick and choose their cases and as a rule operate only upon those who are physically fit. Bateman from the Christian Mission Hospital in Old Cairo does not go into this point. Stiven, however, looking upon splenectomy as an extremely dangerous procedure, and upon the human material to work on as of a very unhealthy nature, describes in detail pre-operative treatment which requires about six weeks in the hospital. As a matter of routine every patient is given a dose of carbon tetrachloride for the ankylostomiasis, and a full course of tartar emetic by intravenous injection every two days for twelve injections. This of course for the bilharziasis and then every patient receives six injections of 606.

FIG. 3.—Œdema of the limbs, ascites, contraindicate splenectomy.

The intestinal track is cleaned and kept clean by daily mixture of rhubarb and soda for the first week. The patients receive a tonic of iron and arsenic, and in addition to the best and most nourishing food, they receive beans which have been allowed to germinate in water for forty-eight hours. This bean soup is apparently specific for pellagra, and others suffering from some vitamine deficient.

Here in the Government Hospital on the Suez Canal these Egyptians have

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the benefit of a splendidly trained surgeon in a well organized and equipped hospital, apparently equal to the two great hospitals in Cairo, and during this pre-operative careful treatment all the laboratory investigations are made.

All three surgeons are of the opinion that œdema of the limbs and ascites contraindicate operations. These three surgeons have not used blood transfusions before, during or after operations except Bateman who is employing an unusual and very economical method, mentioned in *Carson's Operative Surgery*, where he takes the blood from the removed spleen. I will discuss this later. They all give the evening before operation a purge and an injection of pneumococcic vaccine.

The winter nights in Egypt are cold. The hospitals are not heated and all surgeons fear pneumonia. After operation the only method of warming the patient is to surround the bed by series of electric bulbs, which is really a very efficient method.

Operation.—All use spinal anæsthesia. Bateman gives a hypodermic injection of morphia and hyoscine, and then about 0.6 gram of stovaine in a hypertonic saline solution. The needle is inserted between the eleventh and twelfth vertebræ. When the anæsthesia does not extend high enough it is combined with local anæsthesia in the skin and muscle. When the spleen is dislocated and delivered and the patients complain of pain they are given a little light choloroform or ether on an open mask. Dolbey reports that he performs splenectomy under spinal anæsthesia. Stiven gives morphia and atropine one-half hour before the operation. He describes the spinal anæsthesia as follows: The patient sits on the operating table and places his hands over his ears and bends down his head. He uses a two c.c. syringe and a long fine needle, taps the spinal fluid through the eleventh dorsal space, allows no fluid to escape, injects stovaine of the formula of stovaine bouillon of Poylenc Freres. In the Government Hospital in Cairo when I was there in 1924 I saw Mr. Maddon, who was then professor of surgery, perform a number of operations under spinal anæsthesia. It was very simply and quickly done as described here by Mr. Stiven. No general anæsthesia was given, but unfortunately there were no splenectomies during the days I was able to come to the operating room.

Position of Patient.—Stiven allows his patient to lie on his back and does not raise the legs or lower the head. It is his opinion that this prevents headaches. Now and then he may give a little chloroform.

Incision.—Bateman makes an incision in the left rectus with the addition of an incision in the line of the lower border of the ribs, extending from the top of the main incision superiorly and medially down to, but not through the muscle fibres. This allows a greater widening of the infracostal angle. Stiven stands to the right hand side of the patient and makes an incision varying in length according to the size of the spleen. This incision starts at the costal margin, runs parallel to the midline, divides the left rectus muscle into two equal parts.

Intra-abdominal Manipulation.—Stiven describes this somewhat as fol-

lows: After the peritoneum has been opened the exciting part of the operation follows. The whole hand is inserted within the abdomen to find out what adhesions are present because the difficulties depend upon the adhesions which cannot be foretold. When there are no adhesions the whole spleen is delivered. Stiven has ready a dozen big clamps and he applies them to the whole pedicle of the splenic artery and vein; three or four clamps in juxtaposition; then he cuts off the spleen between the third and fourth clamp. The pedicle is transfixed with a long pedicle needle. Stiven has learned this trick from DeMartel of Paris. The needle is threaded with a black and white linen thread. Linen is preferred as its knot is less apt to slip than silk. Black and white threads allow you at a glance to know whether the ligatures are inter-locked or not.

The first ligature is put in the space revealed by releasing number two clamp, and as it is tied number one clamp is released and allows it to be tied tight. Another ligature is then tied around the whole pedicle in position of number one clamp, and then a third is tied in place of number three clamp. Various modifications of this procedure will have to be undertaken according to the circumstances. Very frequently there is a big vessel running from the greater curvature of the stomach to the hilus of the spleen. He picks up the lesser omentum and ties it off, and thus exposes the true pedicle of the spleen.

Frequently there is a very strong adhesion from the splenic flexure of the large intestine to the spleen, and sometimes there are strong adhesions between the spleen and the under surface of the diaphragm. These have to be broken with the fingers and after the removal of the spleen an assistant puts in a wide retractor and the bleeding points are clamped and tied. He takes care to stop every bleeding point. Stiven, you will observe, describes in great detail the ligation of the pedicle, but does not describe the exact manner in which he attacks the adhesions. He told me however that he clamps and ties the adhesions and delivers the spleen just as quickly as he can, and fixes the pedicle with the clamp just as quickly as he can. Dolbey writes that the huge vascular adhesions between the spleen and the diaphragm are carefully ligated before the spleen is removed. He looks upon these adhesions as the chief difficulties. Dolbey clamps and ties the splenic artery by opening into the lesser sac of the peritoneal cavity, thereby separating the splenic vessels from the tail of the pancreas. Bateman writes that after the abdomen is open the vascular omental adhesions are inspected and as many of those adhesions as can be reached are divided and tied before the spleen is delivered. He is of the opinion it is better to tie than to leave clamps on. On the gastro-splenic omentum he prefers double ligature and division if possible before the delivery of the spleen, but this step may have to be delayed.

Adhesions between the spleen and the diaphragm always have to be broken down, but they are seldom very vascular and are separated with ease.

As soon as the spleen is delivered a mop is inserted in the splenic bed. If the gastro-splenic omentum has not been divided as already described it is

now dealt with, then a stout silk ligature is thrown around the vascular pedicle and spleen but this ligature is not yet tied. The vessel between the spleen, and the stomach at the superior angle of the gastrosplenic omentum is doubly ligated and divided. All remaining omental adhesions are tied off. The spleen is rotated forward if necessary. Bateman has not found it possible to ligate the main vessels from the lateral aspect in the big spleen. Sometimes he separates veins from arteries near the spleen and then applies ligatures, but more often like Stiven he doubly clamps the pedicles and divides. In removing the spleen there may be a few remaining adhesions to be clamped and tied. When a clamp has been used on the pedicle the separate vessels are tied before the loose common ligature is tightened and before the clamp is removed. If all the adhesions but the diaphragmatic have been clamped and ligated before division there is very little oozing in the spleen bed. The rent in the lesser sac is repaired.

Closure of the Wound.—All three surgeons close without drainage.

Post-operative Treatment.—Bateman in some instances removes the clamp from the spleen and drains the blood into a 3 to 8 per cent. of sodium citrate solution. He has had three cases. He was able to inject into the patient's vein from 200 to 500 c.c. of the blood obtained from his own spleen. He proposes to continue this practice. He also admits that he might have saved some of his patients if he had given blood transfusions before operation, but he remarks it is difficult to obtain donors in Egypt. This of course is a matter of education, and I feel certain the Egyptians will quickly understand the value of blood transfusions as the people in other countries have. Stiven is of the opinion that these patients should be left absolutely alone. He is afraid blood transfusions will start oozing and hemorrhage. He does not give any water by mouth for twelve hours, nor even saline solutions, later he begins water and for five days a strictly fever diet. Robert V. Dolbey published some notes on blood transfusions in Egypt in the *Lancet*, for September 13, 1924, page 547, and reports forty-two blood transfusions in four years; in thirty the whole blood method, and in twelve the citrate method. These blood transfusions were performed for primary hemorrhage, secondary anemia, and in a few instances preparatory for operations upon individuals suffering with marked anemia from ankylostomiasis and bilharziasis. They have demonstrated among the Egyptians the importance of blood grouping. The work was done by Dr. A. T. Shousha in the Seriological Department of the Government of Egypt. This student found that group four donors were low in proportion as compared to Europe, and he found there was no essential incompatibility in the bloods of the various races of men in Egypt.

Post-operative Mortality.—Dolbey states "our mortality is still low." In the report of the Kasr el Ainy Hospital (Egyptian Hospital in Cairo) for 1923, which was presented to me by the Director, Dr. Saleh Hamdi, during my visit in January, 1925, I find there are recorded sixteen splenectomies for endemic splenomegaly with two deaths which is about 12 per

cent. Of course this means deaths in hospitals. During the same period there were two hundred and seventy-one operations for inguinal hernia with four deaths which is a little more than 2 per cent., and there were one hundred and twenty-three operations for hemorrhoids without a death. There were thirty-one thyroidectomies with one death, about 3 per cent. I find eighty-seven operations for stone in the bladder, fifty crushings, thirty-three supra-pubic and four peritoneal without a death. Splenectomy then was the operation of highest mortality. Stiven gives his mortality in great details. For about nine hundred operations other than splenectomy the mortality is about 10 per cent., while the mortality in the hospital is 14 per cent., and much of this is pneumonia in spite of every precaution. When he follows his cases—and he apparently has done this very thoroughly—the mortality increases to 24 per cent. Sixty-four per cent. are apparently well and able to work. About 5 per cent. are in poor or indifferent health. The remarkable thing is he was able to trace all but 6 per cent.

I think it is just to remark here that social service and follow-up is just about as good in the Delta region and perhaps better than in Europe and in this country. The method is as follows: Stiven sends a few questions to the Omdah or head man of the village and he through the police gets the reply. These are the simple questions—"Is the patient still alive? Has he increased in weight? Does he feel better than before the operation?" Stiven remarks that when the patient dies the head man of the village reports with the most tactful remark "that he died of another disease." Stiven concludes that splenectomy is a dangerous operation requiring especially careful preparation first, but as improvement in general health can only be obtained by splenectomy the means justify the risk. As far as I can make out the destruction of the organism of bilharzia by the intravenous injection of a solution of antimony has no effect upon the enlarged spleen. Undoubtedly as more and more Egyptians come to the hospitals for treatment in earlier stages the number of enlarged spleens will be reduced.

Dolbey writes "we believe that intravenous therapy in bilharzia is reducing the number of enlarged spleens."

The Cause of Splenomegaly in Egypt.—Stiven is of the opinion that the causal factors are not yet definitely proved, but that the enlarged spleen is the result of heavy parasitic infection.

Bateman is of the opinion that malaria is not a factor. Dolbey still believes that "Egyptian Spleno-Megaly" is a bilharzial condition and is different from Banti's Disease. The blood picture is different and they have never found the Leischman-Donovan bodies.

The Spleen.—Unfortunately Doctor Stiven brought with him only sections of the liver and not of the spleen, and up to the present time the specimens promised to me by Dolbey and Bateman have not been received, but in the majority of these spleens unless the patient has had a prolonged pre-operative treatment they find bilharzia ova.

The Spleens of Mummies.—Both Dolbey and Bateman confirm the impres-

sion I got during my visit that the ova of bilharzia have been found in the spleens of mummies dating back to 2000 B.C. These parasites can be brought out by the Armand Ruffer technic by soaking the spleen in glycerine and carbonate of soda. I had hoped to show you a section of a four thousand year old spleen with a parasite in it, but it is very difficult to send out of Egypt things of this kind.

I have not yet received the report of Dr. Georgia Subhy of the Kasr el Ainy Hospital who is the great authority on the special studies in mummies.

Ankylostomiasis and Bilharziasis in Egypt.—I have before me the reports and notes of the Public Laboratory in Cairo. It is published by the Department of Public Health by the Minister of the Interior, and this report is dated 1924. Most of the articles are written by Dr. M. Khalil. There are also contributions by Dr. M. S. Abaza and Dr. A. T. Shousha. This book of almost two hundred pages, splendidly illustrated, is a complete study of these two parasitic infections; the life circle of the organism; just how it enters human beings and how they can be protected, and how the disease can be prevented. Tourists in Egypt run practically no risk of this infection if they are careful of what they eat and drink, and do not go wading barefoot in irrigating ditches.

Prevention of the Enlargement of the Spleen in Egypt.—This undoubtedly is on the way. When I was there in 1924 often five hundred Egyptians came to the hospital on one day for intravenous injection, and the probabilities are that from one hundred to one hundred and twenty seek help through splenectomy each year, but when the Egyptians are properly trained as to their drinking water and food, and how they should not expose their naked bodies to certain kind of drainage water they will neither require intravenous antimony nor splenectomy. Professor Wendell Cleland, Director of the Division of Extension of the American University at Cairo, has started an educational effort to teach the Egyptians village and personal health. I have before me a leaflet entitled "A Student Contest to Promote Village Health," and I am quoting from this interesting publication which demonstrates that the young Egyptians are learning the rules of health and also how to teach others. The following is a direct copy: "The winner of the first prize did his work in the small village of el Hagrasa in Sharqia Province, sixty-six miles north of Cairo. The population of this village is 2579 with 1672 others living on farms in the neighborhood. Although not himself a sheikh entitled to speak in the mosque, this student showed ingenuity in getting health subjects discussed in the places of prayer. To quote from his report: 'Friday, June 3rd, was the last Friday in Ramadan. I went to pray at the chief mosque of the village. After prayer the congregation dispersed quickly on account of the stuffy atmosphere inside. I managed however to hold a goodly number and asked them to listen to the circulars on water and flies. This took ten minutes. I noticed that they showed keen interest. Some of them asked "Is it harmful then to drink any water other than filtered water and pump water?" I explained and they seemed satisfied. The first plunge and the

success it received made me optimistic. This however was cut off by some "Faqueehs" (blind chanters of Koran), who protested against talking on health subjects inside the mosque. They considered this as an interruption of the service and a heated argument followed. They accused me of not being a true Mohammedan, and that I was preparing the way for anti-Mohammedan propaganda, since these circulars were issued by a non-Islamic body. I had to be very patient and at the end succeeded in making a good number believe the importance of this work and its humanitarian object and was thus able to proceed without much resistance.'"

DISCUSSION—SURGERY OF THE SPLEEN

DR. ARTHUR D. BEVAN, of Chicago, Ill., said that he and his associates had been doing most of this splenic work with ethylene, sometimes preceded by a quarter of a grain of morphine, associated with blocking the intercostal nerves on that side with novocaine, and where additional relaxation is needed during some short stage of the operation, possibly a few whiffs of ether.

With regard to ethylene, nobody should use ethylene without taking the necessary very simple precautions to avoid static spark. It costs about twenty-five to thirty dollars to buy a steel mat, ten by twelve feet in dimension, upon which should be placed the operating table and the gas machine. The steel mat should be connected with the plumbing. This eliminates, he believed they had demonstrated, entirely the danger of the static spark. Of course, any individual who uses a cautery in the presence of ethylene or ether, where an explosion can occur, should be barred from the operating room.

Ethylene acts admirably in the great majority of these cases. He could not see any sound reason why spinal anæsthesia should be used in these cases, because the sequence of ethylene and ether has been so satisfactory in their experience.

DR. FRANK K. BOLAND, of Atlanta, Ga., said that in addition to the splenomegalies, which had been under discussion, he would like to speak of the opposite kind of spleen, the spleen which is seen in cases of sickle-cell anæmia. So far, there have been about eighty cases of sickle-cell anæmia reported in the literature. Four have been recognized in Atlanta. This disease is a familial disease, and so far has been found only in the negro or mulatto. Five operations have been reported, with four recoveries and one death. This one death was a case that was operated upon by the speaker. It was a negro man, twenty-eight years of age, who had been sick about ten years. He had the characteristic symptoms of the disease—weakness, attacks of abdominal pain referred to the left hypochondrium, and leg ulcers which were very difficult to heal. These are outstanding characteristics of the disease, accompanied by the weakness and dyspnœa which go with most cases of anæmia. A slide showing the spleen which was removed from this man was shown on the screen. The spleen weighed fifteen grams, and was about 7 cm. in length. It was very difficult to remove, much harder to remove than a large spleen.

The patient stood the operation well and left the table in good condition but he died about six hours later. They were unable to obtain an autopsy. The cause given for his death was embolism.

It might be asked whether this was an accessory spleen on account of its small size, but this organ was in the exact anatomical location for the spleen, and he did not see how it could have been accessory. The four other cases operated upon with recovery have shown an amelioration of the symptoms but not an entire cure.

DISCUSSION

Of course, the most characteristic sign of this disease is the sickling of the blood. He then showed a second slide depicting another spleen which was removed at autopsy which is even smaller in size than the one which he removed, weighing about 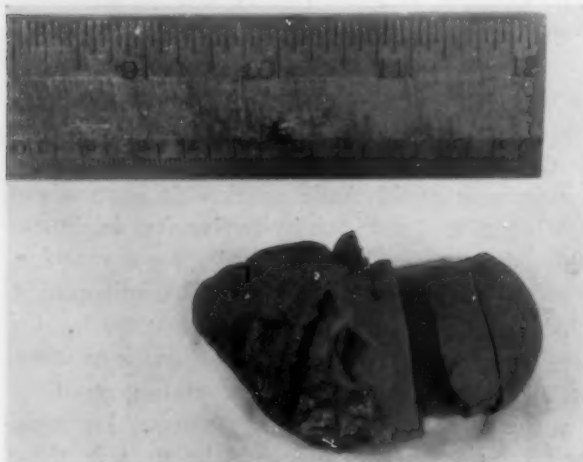twelve grams. This was followed by a third slide showing the blood with the sickling which is so characteristic of the condition. In his case about 20 per cent. of the red cells showed sickling. The percentage of sickling in these cases runs from 2 to 50 per cent. In this man, the leucocyte count was 45,000, an average leucocyte count for this form of anæmia. He had 3,000,000 red cells and about 60 per cent. hæmoglobin.

Fig. 1.—Spleen weighing 15 grams removed from case of sickle-cell anæmia.

The only other disease in which he had been able to find a diminutive spleen like this is in leprosy, in which a spleen removed at autopsy weighed only two and a half grams. He could not see how the removal of these diminutive organs can have much good effect on the patient. About half of these cases show a slightly enlarged spleen and about half an undersized spleen. It is believed that the diminutive spleen is found in a later stage of the disease.

Dr. William D. Haggard, of Nashville, Tenn., said there have been something less than one hundred cases of sickle-cell anæmia reported, about twelve of whom have had splenectomy. A very considerable majority of these have been greatly benefited if not entirely and completely cured. It occurs exclusively in the negro.

The characteristic of the disease, as they have observed it, has been an anæmia of a secondary type, more or less grave, associated with abdominal pain, inflammation of the joints, and leg ulcer.

They have noticed the familial character of the disease, the hereditary character, and were interested to pursue some studies in regard to the occurrence of it in normal individuals.

Lawrence tested the blood of a hundred students and nurses at the Vanderbilt University and found 2 per cent. of that number to have sickle cells. Then he studied another hundred colored people in the Meharry Medical College and found about 3 per cent. showed these cells.

Among these patients who did not have typical sickle-cell anæmia, he encountered the cell in an elderly white woman who complained of inability to walk, which was really due to a hemiplegia. She did, however, have some

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evidences of splenic anæmia and petechiæ. The interesting thing was that her sister and brother and one niece also had the sickle cell, but another brother and another sister did not have it.

DOCTOR HAGGARD then displayed on the screen slides showing a typical example of Bishop's drawing of the sickle cells. They are very typical, very unusual, and very bizarre. Elongated cells are in the same slide with sickle cells. Others have the sausage-shaped cell as well, and in one man who was perfectly well and healthy—a white man, too, were found sausage-shaped cells.

The sickle cell, the sausage type, and the filamental elongated variety are typical of this disease.

One of their splenectomies was in a woman sixty-two years of age who had splenomegalous leukemia with a white count of 144,000, but under radium it was reduced to 12,000. We were content with her improvement and did not consider splenectomy for the leukemia but she had such severe gall-stone attacks that they were obliged to operate for that, and removed the spleen also and had the satisfaction of her being alive and well at the end of five years.

DR. EUGENE H. POOL, of New York City, called attention to the bone involvement in Gaucher's disease.

The characteristic cells which are peculiar to this disease are distributed not only in the spleen but also in the liver, lymph-nodes and bone-marrow. Such wide distribution occasions uncertainty as to whether the condition should not be regarded as a systemic disease rather than a specific splenic lesion, and whether removal of the spleen influences the disease beyond the relief of the patient through the removal of the mass.

So few cases have been reported and followed (four years ago only about forty cases were on record), that the incidence of skeletal involvement and its effects are difficult to estimate. Yet Ludwig Pick, in a recent article on the bone lesions of Gaucher's disease, has reviewed the subject and states that the lower end of the femur and lower end of the tibia are the situations most often involved, but he cites involvement also of most of the other bones, for instance, the phalanges, sternum, ribs, skull, etc. He states that the lesions are first small foci of cells, and that these foci later coalesce, giving under the X-ray a peculiar mottling.

DOCTOR POOL related the history of a Jewish woman, twenty-five years of age, who was operated upon in January, 1921, and a spleen of over 3,000 grams removed. This showed the typical picture of Gaucher's disease, (ANNALS OF SURGERY, vol. lxxiv, 1921, p. 635). Since that time, over seven years, her health has been good with one exception.

Four years ago her left hip became painful. It was put in plaster in another hospital for six weeks and the joint is now immobile and painless. She has a decided limp. The blood shows slight secondary anæmia. The X-ray studies by Doctor Belden, of the New York Hospital, are of interest.

Examination of the skull and other bones shows no evidence of disease except in the left hip-joint, where there is a definite destructive process involving the head of the femur. The head is mottled in appearance and there is a definite bone absorption taking place, with the addition of some irregular calcification. The head is triangular in appearance. The greater trochanter shows a definite decalcifying process and the medullary substance in the shaft of this femur shows mottling for about two-thirds of the shaft. These changes were interpreted as involvement of the bone as the result of Gaucher's disease. This case will be carefully followed in the hope that it will be possible to report later significant developments.

DR. MAX BALLIN, of Detroit, Mich., said he had had the opportunity to examine two patients with an unusual type of splenomegaly; one in Harper Hospital, and one the patient of a surgeon outside of Detroit. Both of these cases were operated upon and the spleen had been examined microscopically. The cases were both of middle-aged persons, one thirty-five years old, a woman; the other forty years old, a man. The splenic tumor had existed for thirty or more years, as long as they could remember. They had no special complaints except a tired feeling and the presence of a large splenic tumor. The red cell count was three and a half millions. There was no anæmia and no fever. There was a leucocytosis of 25,000, however, and nucleated reds up to 10 per cent. and more. The spleen specimen showed very interesting cell enclosures, practically bone-marrow enclosures in the spleen, as will be seen in slides presented (Figs. 1, 2, 3, and 4).

This type of splenomegaly is hard to understand and is most likely a congenital enclosure of aberrant bone-marrow cells in the spleen. Dr. Plinn F. Morse, the pathologist at Harper Hospital, published these two cases with the speaker in the *Journal of the American Medical Association*, November 12, 1927, vol. lxxxix, pp. 1671–1672. He suggested the name "Myelophthisic Splenomegaly".

After operation the condition of the blood did not change at all. One patient has been observed for over eight years without any change in the general condition, the blood count staying exactly the same as before splenectomy.

DR. DAVID CHEEVER, of Boston, Mass., made a suggestion in the field of technic. Reference had been made to the advisability of conserving the blood in the spleen by collecting it after its excision, citrating it, and reinfusing it. Now, in many cases of enlarged spleen it is quite possible to operate, to deliver the spleen, secure the arterial supply entirely separately, and then pick up the smaller branches until there is nothing left but the large splenic vein. The spleen is then held up and gentle pressure can be applied, if there are no bacteria or toxic products which might get into the circulation. Under these conditions the spleen shrinks in size beneath one's hands. Then after the vein is ligated and the spleen removed, there will be practically no bleeding from the pedicle. That is a very effective way in suitable cases of conserving all of the blood which otherwise might be lost.
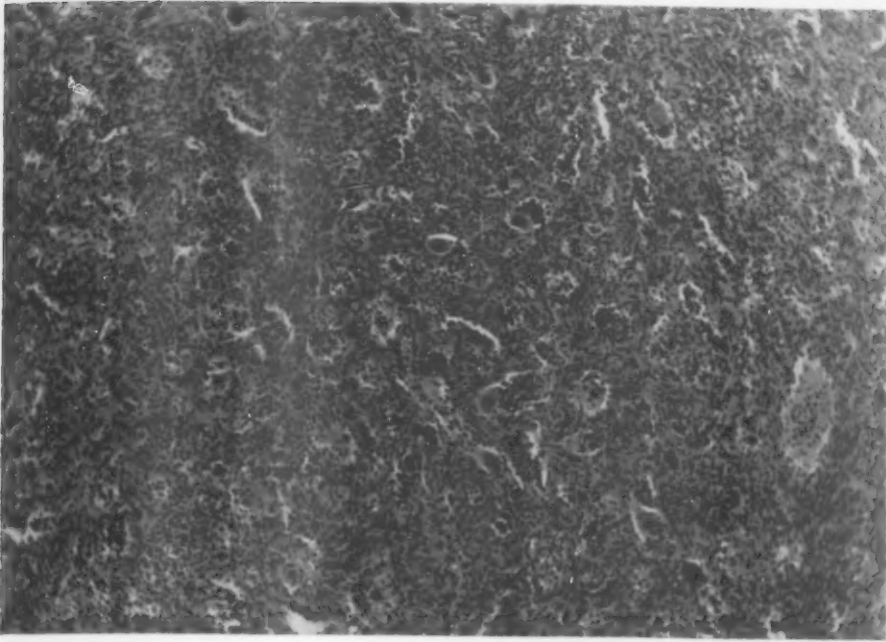
FIG. 1.—Low power. Myeloid islands and bone marrow giant cells scattered throughout the spleen pulp.
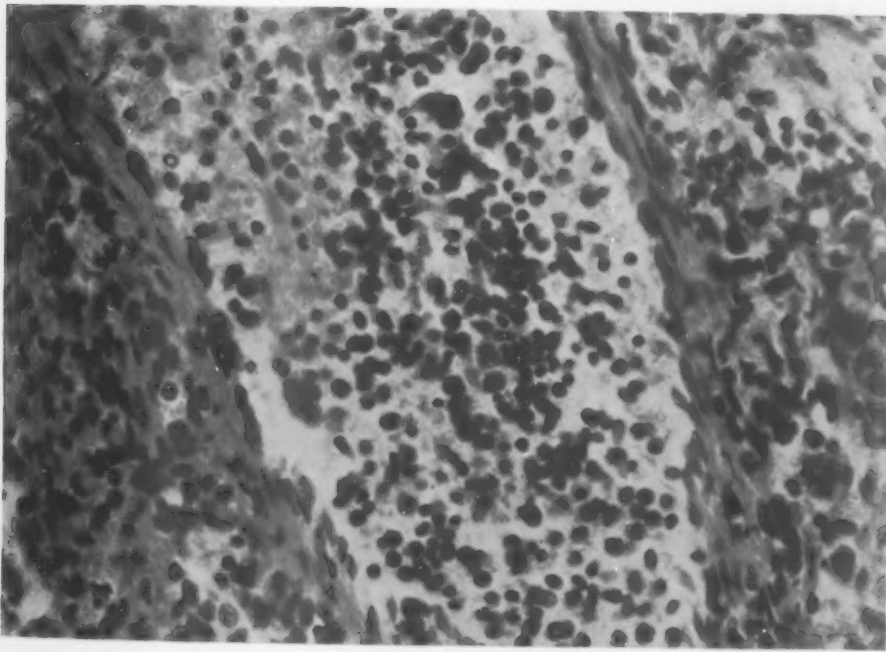

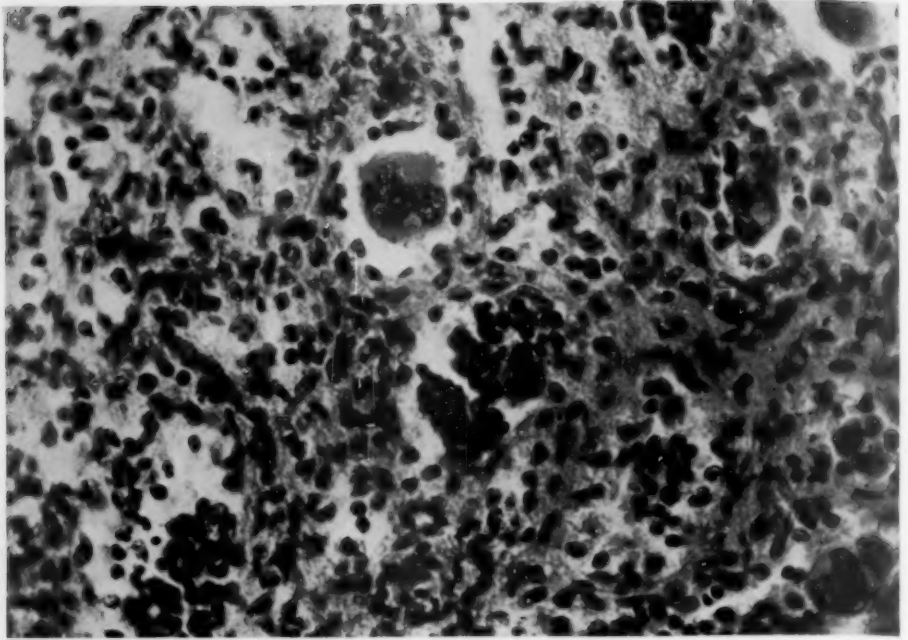FIG. 2.—Splenic vein showing large numbers of nucleated, immature cell types.

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Fig. 3.—High power. Bone marrow giant cells and myeloid areas in spleen sinuses.

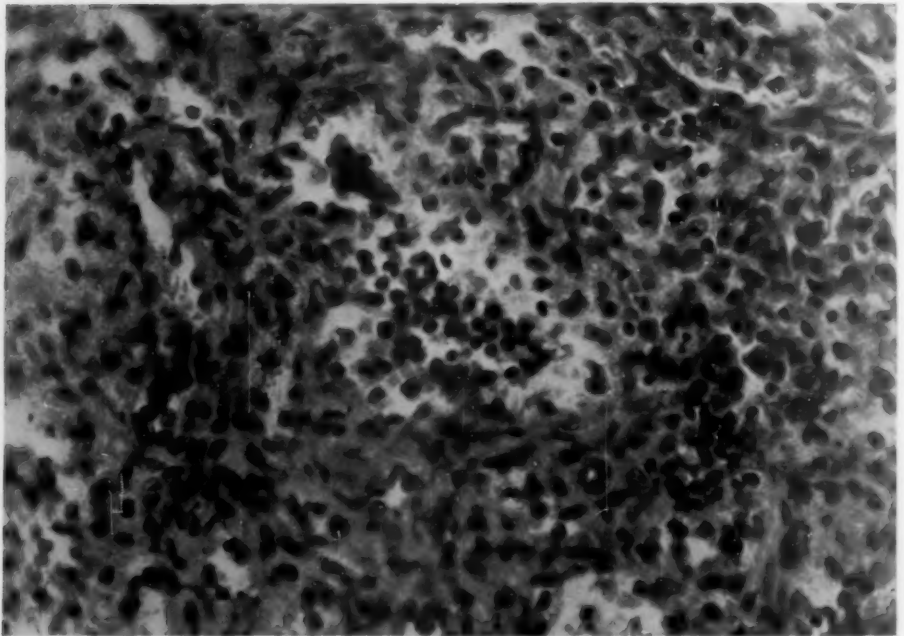Fig. 4.—Myeloid areas in spleen sinuses.

DR. JOHN H. JOPSON, of Philadelphia, Penna., said, with regard to the question of technic to which Doctor Cheever had alluded, he practiced in one case the reinjection of citrated blood after the spleen was removed. It was a pure afterthought, the spleen having been thrown into a sterile basin, and seeing a large amount of sterile blood which was being lost, he suggested that it be citrated and transfused, which was done.

Doctor Jopson remarked further that there is a type which has not been discussed here to-day, namely, malarial splenomegaly. He had had a case recently in an Armenian girl, seventeen years of age. Splenectomy for malaria is an unusual operation in the vicinity of Philadelphia. This girl contracted her malaria in Armenia, from which country she had fled recently, by reason of the massacres, to the United States. When she was admitted to the Presbyterian Hospital it was mainly because of symptoms which suggested cholecystitis to her physician, who was himself an Armenian, had practiced in that country and Persia, and was familiar with the type of splenomegaly which she presented. Her symptoms were strongly suggestive of chole-cystitis in spite of her youth, and she had quite a marked but transient jaundice on her admission to the hospital. Operation was decided upon; the first search was made through a mid-line incision for disease in connection with the biliary passages. None being found and the liver being healthy, they removed the spleen, which weighed 460 grams, or about three times the normal size in the female. It presented the characteristic histology of the malarial spleen, according to Dr. John A. Eiman, the pathologist to the hospital. She made a smooth recovery, has gained in weight and is the picture of health.

Doctor Billings in his paper made reference to the operative technic in cases of abscess of the spleen and spoke of exploratory puncture. It seemed to the speaker that this should be reserved for abscesses arising from the upper pole, which is the most frequent type of solitary abscess. It is unfortunate that splenic abscess is so commonly simply a by-product in cases of pyemia. The abscesses are multiple and do not lend themselves to drainage, but occasionally solitary abscesses do occur as a result of hæmatogenous infection. When they are located in the upper pole and when they perforate the capsule and when, as they sometimes do, they give rise to subphrenic abscess, then the problem is similar to the common subphrenic abscess on the right side, and then posterior aspiration is justifiable, and posterior approach and drainage are indicated.

DR. WILLIAM J. MAYO (in closing the discussion) mentioned some of the misfortunes that may come to those who remove the spleen, at least misfortunes that had come to him.

First, the surgeon must make up his mind before he starts whether or not he will take the spleen out. Once the operation is begun, there is no place to stop, because the blood vessels are underneath the spleen, and the hæmorrhage cannot be controlled until the spleen is out.

DISCUSSION

Before bringing the spleen to the outside of the abdomen, it is best first to free the spleen from all its attachments except the pedicle and push the spleen downward, as Doctor Balfour pointed out ten or twelve years ago, to prevent the jejunum from entering the splenic space. Then pack a large hot wet gauze roll into the splenic space to control the venous bleeding. As a rule, by the time one is ready to remove the pack, the bleeding will have stopped, but not always. In half a dozen cases at least he had been compelled to place and leave a large pack in the bleeding space. In the first case he sutured the abdomen, leaving the pack in place, and tied the sutures in double bowknots so that he could reopen the abdomen in forty-eight hours and remove the pack. This resulted in a protracted convalescence. In the other cases he brought the ends of the gauze out through a stab wound in the left loin at the twelfth rib, and in due time removed the pack from the cavity through the stab incision. In one instance he did not realize how large the cavity was after removal of the pack, and a subdiaphragmatic abscess resulted that required operation about six weeks later because of the residuary fluid that was left in the pocket. It is best, therefore, if a pack is left, to remove it on the sixth day or later and insert a catheter to be left in place for a considerable time to be sure that a residual pocket does not form.

Second, the stomach may spread out over the splenic pedicle and may not be identified. In two early cases he accidentally opened the stomach, and in each gastric contents escaped. He was able to suture the gastric opening in both cases. One of these patients died. Obviously one should be sure not to mistake the stomach for part of the pedicle.

Third, in two instances he had removed a large part of the tail of the pancreas. In the first case he did not remember that the tail of the pancreas comes up into the pancreatic notch of the spleen. When the specimen was brought from the laboratory about ten centimetres of the tail of the pancreas was found to have been tied off with the splenic pedicle. Since then he had been very careful to dissect out the tail of the pancreas.

Fourth, in suturing a large adherent area on the under surface of the diaphragm where large veins are bleeding, it is easily possible to tear the diaphragm. This happened with him once. He had the catgut needle in a long Haggard needle holder in order to reach up into the bottom of the cavity. As he put this needle into the diaphragm he should have remembered the force of the contraction of the diaphragm in expiration, but he did not, and held onto the needle with the forceps. The needle tore through the diaphragm and pericardium, and the apex of the heart dropped down into the opening. He was able to suture the rent and the patient got well, but the possibility of this accident is one that must be remembered. When the needle is placed in the diaphragm, have ten inches of catgut free, let go of the needle, and pick it up when inspiration brings it down within reach.

Dr. Arthur D. Bevan (in closing) recalled a quotation from Billroth in which he refers to his great master, Langenbeck, and he makes the statement that the great strength of the Langenbeck school lay in the fact that he

taught his pupils the anatomy and the physiology of the science, and that it was of great importance, the most important thing that he taught, and that that school was continuing still as a great school of surgery.

Doctor Bevan thought that surgeons get too far away from anatomy sometimes. He suggested that surgeons who are doing a good deal of this spleen work should get in contact with some friendly pathologist and get the opportunity of testing out the different exposures of the spleen on very fresh post-mortem material. He was quite converted to the position that for all purposes it is wise, in doing a splenectomy, to start with a mid-line incision. One then sees what the conditions are, and if it is absolutely essential, because of the size of the spleen or because of adhesions or hæmorrhage, to obtain a very wide exposure, one can obtain the best exposure by a complete division of the rectus. By this means there may be secured a very much greater exposure than from an incision parallel with the costal arch, or any other incision, because this huge flap can be carried right up over the costal arch, and the incision does not carry any danger of injury to the nerve supply, and lends itself very well to closure without any possibility of hernia.

One can carry on to advantage such anatomical studies not only in this spleen work but in all sorts of operative work. One can acquire in this work on fresh cadavers a mental conception which is really of very great value in the operating room in handling some of these difficult problems.

In many of these spleen lesions, the surgeon should keep in mind the fact that the spleen is simply one part of a very complicated reticulo-endothelial system, and that the mere removal of the spleen does not always clean up the case entirely and remove all of the pathology. This is quite evident in splenic anæmia, where very frequently, in 10 per cent. or more of the cases, hæmorrhage recurs in these patients even after the removal of the spleen. That is also true in hemolytic jaundice. He had had one very marked case of hemolytic jaundice where, after the removal of the spleen, the jaundice has persisted, and the picture, as far as fragility is concerned, is exactly the same as it was before.

Another striking illustration of this is the case that Pool referred to, of Gaucher's disease with a deforming arthritis of the hip-joint. Undoubtedly Gaucher's disease involves the entire reticulo-endothelial system. He had a case exactly like Doctor Pool's case, of a woman who has had an enlarged spleen for fifteen years with this same deforming arthritis of the hip-joint; that woman had been operated upon twelve years ago—she was operated on twelve years ago; but the man making the incision thought it was a kidney and made a kidney cut and did not remove the spleen. If that spleen had been removed and she had lived fifteen years, we undoubtedly for a long period would have said that she had been cured of Gaucher's disease by splenectomy. But she now comes back to me with an enormous spleen. She has had two children since this exploratory operation, she is in fair health in spite of this deforming arthritis of the hip. It is a difficult thing, with present knowledge, to make sharp lines of division between these dif-

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ferent conditions. Undoubtedly many of these splenic conditions fade into each other and we are not as yet able to make very definite classifications.

DR. ALLEN O. WHIPPLE, in connection with the patient that Doctor Pool referred to, spoke of a case of Gaucher's disease in a woman, in a family in which the brother also had had it, and who was operated upon, who at the time of the splenectomy had a peculiar hip condition. As a matter of fact, she had been referred from the New York Orthopedic Hospital because of the enlarged spleen.

After splenectomy she returned to the New York Orthopedic Hospital for purposes of investigation of the hip-joint, and it was thought at that time that she might have some low-grade pyogenic infection of the joint. A simple exploration of the joint, however, revealed no evidence of a suppurative lesion and nothing more was done than to remove a specimen and immobilize the hip-joint for a period of some six to eight weeks. The sections showed the same type of cell as had been found in the spleen.

That patient has been followed now for a period of four years. She has continued to improve and is now able to walk and dance without any discomfort or disability.

He further called attention to a point in technic which may possibly arise in some cases of Banti's disease, the vessels in splenomegaly and Banti's disease are sometimes markedly atheromatous and thickened. He had a very trying experience in a case on which he was doing a splenectomy. In tying the ligature on the artery, he found that the ligature cut right through the atheromatous vessel, and there was an immediate hæmorrhage of very severe type. Attempts to hold the stump of the vessel and to apply another ligature failed because that also cut through the artery. He was faced with the impossibility of applying any clamp or instrument of that sort, and it occurred to him that he might use the tail of the pancreas as a buffer. The needle with the suture was accordingly carried through pancreatic tissue, with the result that the vessel was tied and controlled. Although he watched the patient with great anxiety for fear of having damaged the pancreas and caused a pancreatitis, none developed, and the patient apparently did not suffer from this emergency procedure. It may possibly be a useful procedure in an extreme case of that sort.

DR. ARTHUR E. BILLINGS (in closing) referred to the remarks of Doctor Jopson, on the question of exploratory puncture. It was his intention to stress its confinement to the cases where the progress of the abscess is toward the thorax as suggested by the existence of pleural and pulmonary symptoms. Melchior collected seventeen cases of abscess following typhoid fever in all of which exploratory aspiration was practiced without any untoward effects whatever. Morrell, Dambray and Tappe stated that no untoward development had followed the diagnostic puncture. One point may be emphasized in this connection and that is that diagnostic puncture should be confined to the cases where there is a thoracic evolution of the abscess, and when one is prepared to go ahead with operation immediately after puncture, if the results so indicate.

SURGERY OF THE SYMPATHETIC SYSTEM. INDICATIONS AND RESULTS *

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The surgery of the sympathetic system meets two kinds of difficulties, those which spring from our physiologic ignorance, those which spring from our pathologic ignorance. On one side, we do not know the exact significance of the branches that we cut, on the other side we are ignorant, as a rule, of the cause and the exact mechanism of the diseases which we wish to cure. One understands that in such conditions, surgery acknowledges failures and incomplete results. It is astonishing that it can count so many successes.

Before indicating briefly the results that I have obtained after having made about 400 operations upon the sympathetic system, sixty-four upon the cervical chain, three upon the thoracic sympathetic, sixteen upon the lumbar or sacro-sympathetic, 298 upon the periarterial sympathetic, it is necessary to emphasize three points to which I attach great importance. First, contrary to what has been admitted by most physiologists and which is most in conformance with the old views of François Frank, the sympathetic system appears to us more and more as a vast sensory system everywhere with reflex associations. The researches that we have pursued for the last four years show that it has its own sensitiveness, having its special field not connected with cerebro-spinal sensitiveness. This sensitiveness is in direct relation to the vasomotor reactions which seem controlled by intraparietal peripheral centres. In every case, one fact is absolutely certain— no sympathetic section produces any vasomotor paralysis. Every sympathetic operation (ganglionectomy, ramisection, section of a sympathetic trunk, periarterial sympathectomy) is always followed by an active vasodilatation more or less lasting. This makes itself felt especially distally, but one can find traces of it proximally and often on the opposite side. It is accompanied by increased heat which lasts longer than the oscillometric signs of the vasodilatation. I have found from two to three degrees more temperature on the operated side after ramisections at the end of two years.[1] These are facts which tend to show that neurotomies of the sympathetic are sensory neurotomies and not motor, setting free the periphery from a central control. In general, the section of a sympathetic chain or of its branches has effects of the same kind as ablation of its ganglions. These being certainly important centres of conduction, should be respected as much as possible

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[1] Leriche and Fontaine: Experimental and Clinical Contribution to the Question of Innervation of Vessels. Surgery, Gynæcology and Obstetrics. Unpublished.

* Read by title.

and should not be sacrificed if one can avoid it. The surgery of the sympathetic should attempt to be selective and as conservative as possible.

Every sympathetic neurectomy is followed by the formation of a cicatricial neuroma. In certain patients, this neuroma becomes the point of departure of reflex reactions which reproduce secondarily the primary disease, or syndromes that resemble it. If one infiltrates such a neuroma with novocaine, one may obtain an immediate disappearance of all the existing signs lasting for some hours. If one resects the neuroma, the cure is obtained anew, temporarily at least. A relapse is always possible. One should seek the best method of shunning the formation of voluminous neuromata. Attempts essayed for this purpose have hitherto not given any results.

I submit now the principal results that I have obtained and the conclusions to which they give rise.

A. SYMPATHECTOMIES IN VISCERAL DISEASES.

1. *Angina Pectoris.*[2]—The ideal operations involve two steps:

a. Chief indispensable step: section of the communicating branches which are derived from the controlling ganglion (V, VI, VII, VIII cervical, I dorsal), and

b. A complementary intervention upon the superior cervical sympathetic, consisting either of ablation of the superior cervical ganglion, sympathectomy of the upper cervical trunk, section of the upper cardiac nerves or a simple sympatheticotomy operation to which one may join, the case having failed, section of the depressor nerve.

The surgical treatment of angina pectoris is based upon sensory and not motor considerations. The operation should be done preferably on the left side but sometimes one must test by novocaine infiltrations at the base of the neck which is the side of choice. I have done this once. I have, with Fontaine, operated upon five anginose patients. Two bad cases (aged patients with incurable heart lesions) have been relieved, not cured, who died six and nine months, respectively, later. One patient has been relieved for eighteen months but has experienced some crises. One case is too recent to be counted. One case remains cured since March, 1925.

2. *Bronchial Asthma.*—There exist here the same indications for operation as in angina pectoris, although one would search in a given case whether it may not be better to attack the pneumogastric than the sympathetic. When one has to do with an asthma engrafted upon a chronic bronchitis with marked emphysema, it is necessary to prepare the path for the nerve operations by a removal of costal cartilages for the purpose of mobilizing the thorax which is in a state of rigid, extreme dilatation (operation of Freund) and maintains the emphysema. On five patients operated upon by the ablation of the left star ganglion, two were followed by no result, two were radically cured. One of these cases dates back three years, the other thirty months. They have been recently seen. One late case, benefited by the operation of

[2] Leriche and Fontaine: Surgical Treatment of Angina Pectoris, What It Is and What It Should Be. American Heart Journal. In Press.

Freund but the condition aggravated by the removal of the star ganglion, has been cured by right vagotomy. For twelve months he remains without attacks.

3. *Basedow's Disease.*—Ablation of the left upper cervical ganglion benefits most of these patients and cures some of them completely, but the thyroid operations have more complete and more constant results. I reserve such an operation as that of Jaboulay to cases of Basedow's disease without goitre. I know of cases cured for several years excepting for a slight exophthalmos. In severe cases, the sympathetic section prepares the ground marvelously for the thyroid operations, but in view of recent progress in medical treatment, especially since the introduction of iodine preparations, the indications for operation no longer assert themselves as in former times.

4. *Gastric Crises of Tabes.*—Dorsal ramisection is to be preferred to posterior radicotomy, but it is necessary to remember that these patients always have a recurrence at a more or less distant period.

5. *Gynæcological Affections.*—In painful dysmenorrhœa without objective cause, in amenorrhœa without cause, I obtained with hypogastric sympathectomy considerable and lasting amelioration. I have seen re-appear a menstruation which has been absent for a long time. In sclerocystic ovaritis, I obtained from perihypogastric sympathectomy, or section of the pre-sacral nerve of Cotte, disappearance of pain without mutilating operation. In vulvar kraurosis with hypogastric sympathectomy an almost complete cure (disappearance of the leucoplasia, of the retraction and the vaginal dryness) in a case which I followed for three years. In other cases the amelioration was less satisfactory.

6. *Painful Syndromes in Pelvic Cancers.*—In inoperable pelvic cancers or after radium therapy, one is often obliged to intervene for the relief of persistent pain. In four cases the sympathectomy of the hypogastric arteries, primary iliacs and the termination of the aorta, have given me at times complete relief of the pain. These operations have demonstrated that in pelvic neoplasms (prostate, uterus) the arteries are involved in a quite marked lymphangitic sclerosis. I prefer this type of operation when it is possible to the cordotomy which too often gives bladder troubles and pyelonephritis.

B. SYMPATHECTOMIES IN AFFECTIONS OF THE LIMBS.

1. *Painful Syndromata.*—In the neuralgias following gunshot wounds, I have had six excellent results giving return to normal state and to active life; two cases of amelioration with diminution of pain without real cure and two complete failures, that is to say, four failures in ten cases. In cases of diffuse post-traumatic pain (old ascending neuritis), periarterial sympathectomy has always failed. On the contrary, I have had very great improvement, one might say lasting cures, from ramisection (three cases). In painful stumps, it is necessary to distinguish pain localized in a nerve trunk which may be cured by resection of the neuroma, from diffuse pains in the stump, associated with vasomotor trouble and ulcerations, which are healed by periarterial sympathectomy, and from major pains in the stump

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with marked mental disturbances which give way only to posterior radicotomy and to ramisection. In the cases of pain with cyanosis, complicated with œdema, and trophic disturbances, I have had four cures in six cases; two of which have been followed up for two and three years respectively. In the class of major pains, posterior radicotomy has given me two good results and two failures. Ramisection in four cases has given me a cure lasting for three years, two cases of marked improvement and one relapse after operation upon the stump. This case has later been re-operated by posterior radicotomy and remained cured now for five months.

2. *Vasomotor Disease.*—The name "Raynaud's Disease" should be reserved for diseases purely vasomotor in their nature according to the typical description of Raynaud, exhibiting complete integrity of the circulation in the interval of crises. I agree with Allen and Brown (*American Journal of Medical Sciences,* vol. clxxiv, September, 1927, pp. 31 and 329), in admitting that many arterial diseases, especially arteritis, simulate at the beginning Raynaud's Disease. This diagnostic error should be avoided. In true Raynaud's Disease, simple periarterial sympathectomy done on both sides produces a permanent cure. I have recently seen a young girl upon whom I operated April 5, 1924, for a condition marked by typical crises and normal circulation in the intervals. I did a perihumeral and a perifemoral sympathectomy. The patient has remained well for four years.

A butcher subjected to unilateral sympathectomy in February, 1924, has remained cured on the side operated for two years but has had crises on the other side.

A woman, sixty-eight years of age, operated upon November 13, 1924, was well in April, 1926.

In certain cases I have combined ramisection with the periarterial sympathectomy. I have obtained thus, with Fontaine, very good results in a bad case. In this patient the disappearance of the painful crises has been maintained for two years and two months. But one will always miscarry if one makes an error in diagnosis and mistakes as Raynaud's Disease arteritis or a thromboangiitis of Buerger.

In Acrocyanosis.—I have obtained a good result in the only case upon which I have operated. This patient has just been married, eighteen months after operation and is in an excellent state of health.

In Erythromelalgia.—Sympathetic operations fail.

In Sclerodermia.—The sympathectomies give very noticeable results. In isolated sclerodactylitis, periarterial sympathectomy alone may be sufficient, but the combined operations are demanded in severe cases where the manifestations are multiple, even if not generalized, and in which there are large parchment-like areas manifestly incurable. Personally I have operated upon three cases of sclerodermia and in one case of chronic atrophic dermatitis (Disease of Herxheimer-Pick). In the first case, I did, in December, 1924, a double perihumeral sympathectomy, followed after a brief interval by abla-

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tion of the superior cervical ganglion on the right side and an inferior cervical
ramisection on the left. The improvement was at once very considerable and
at the end of three years the progress of the sclerodermic condition seemed
arrested in the face, which no longer presented a fixed and immovable mass.
At present, the mobility of the fingers is perfect and the sensibility of the
ungual tips very good. The result is certainly much better than could have
been hoped for. So also in two other cases as well as in the case of Herx-
heimer-Pick's disease. In Germany, Bruening and Stahl, Horn and many
others have noted equal successes.

3. *Organic Diseases of the Arteries.*—By the vasodilatation which it
produces in a constant manner, sympathectomy is susceptible of useful
employment in arterial lesions accompanied by a diminution of the peripheral
blood supply or which are aggravated by spasm, producing a condition in
which the peripheral capillary net-work is dilatable and the blood supply is
restored. We shall consider in succession sympathectomy in (a) traumatic
lesions of large arteries; (b) arteritis of the aged; (c) arteritis of the young.

Traumatic Arterial Lesions.—In traumatic lesions of the arteries, one
may make use of periarterial sympathectomy either to favor the establish-
ment of collateral circulation or to avoid the troubles engendered by a liga-
ture or by post traumatic thrombosis. In order to favor the establishment
of collateral circulation after sudden ligature of a large vessel, the best way
to act is to substitute for the simple ligature resection between two points as
proposed by the author at the 31st French Congress of Surgery (Strasbourg,
1921). In this way, one accomplishes a sympathectomy by which the troubles
of the ligatures are avoided. With the same idea Scalone has suggested sym-
pathectomy to be done upon the segment proximal to the ligature, which gave
him excellent results in two cases. Quite lately, I have resected in this man-
ner the whole of the obliterated segment, about 10 cm. in length, from the
external iliac artery of a man who, half an hour before, had sustained a severe
contusion of the inguinal region. This man recovered without incident and
presents in walking not the least vascular trouble. The troubles occasioned
by a ligature or a post traumatic thrombosis do not all depend upon the
ischæmia. Certain of them depend, no doubt, upon the lasting irritation of
the periarterial sympathetic at the level of the obliterated vascular segment.
The resection of this segment causes a cessation of the spasms which had
resulted. I think it necessary each time that an artery is obliterated and that
vascular suture is not possible, that an arteriectomy should be done extending
into healthy tissue in order to escape the vascular troubles which may develop
from the obliterated fragment. Since 1917, I have followed this practice and
never had to regret it.

Arteritis of the Aged.—In the arteritis of the aged, operations upon the
sympathetic can have only a palliative value. As far as symptomatic opera-
tions go they may be directed: (a) against pain; (b) against intermittent
claudication; (c) against ischæmic gangrene.

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a. *Against Pain.*—Among the aged who suffer from arteritis, those whose pain is premonitory of gangrene and is accompanied by vasomotor crises with coldness and phases of cyanosis of the extremities, are most usually relieved by periarterial sympathectomy; of eight cases so operated upon by me, three resulted in complete failures, two in moderate amelioration and three in complete disappearance of the pain, two of which later enjoyed a long period of immunity. Brüning, Kappis, Uffreduzzi, Pieri and Chastenet de Géry have had equally satisfactory results. When, on the contrary, the pain assumes a pure neuralgic character, I think that a periarterial sympathectomy must be abandoned in favor of multiple neurotomies after the method of Quénu. Sympathectomy is equally contraindicated when there exists manifest signs of peripheral vasodilatation.

b. *Intermittent Claudication.*—This in itself appears to me to be a bad indication for sympathectomy.

c. *In Beginning Ischæmic Gangrene.*—Sympathectomy has often been tried in the hope of thus limiting the necrotic process so as to permit limited amputations (Chastenet de Géry). Jianu and Handley have reported excellent results from this procedure and Calandra and Uffreduzzi have shown that successes may be lasting. Failures are, however, not rare. My personal experience comprises but eight cases. I have noted in five cases no results, but in three cases the sympathectomy permitted me to limit the amputation to the sacrifice of the gangrenous parts alone. These patients healed perfectly. It seems then that sympathectomy may be useful in certain cases and that it is not so in others. But one never loses anything by trying. On the contrary, it often permits one to appeal from the classic formula which advises to do always a high amputation in arterial gangrene. For example, one would amputate through the thigh for a limited gangrene of the foot.

Chronic Arteritis in the Young.—Although it may be indisputable that periarterial irritation of the sympathetic explains a good part of the troubles which patients suffer who are attacked with juvenile arteritis, it seems to me not less sure that from *a priori* reasons the extent and dispersion of these lesions would render of no avail all therapeutic attempts through sympathectomy. I have also always been opposed to the employment of a periarterial sympathectomy in cases of chronic juvenile arteritis and I have never considered that it had a place either in intermittent claudication or in the painful vasomotor manifestations which accompanied the affection. So, notwithstanding very appreciable results have been reported from divers surgeons, I see for sympathectomy in the treatment of juvenile arteritis but one indication: namely, the existence of pain of a vasomotor type. Up to this time, I have operated upon twelve patients, eight of whom suffered from Buerger's type of disease, but even in these cases the effect of the sympathectomies is very transient. There are only two lasting successes. All the other patients relapsed rapidly within a space of a few days to some months. Influenced by the researches of Oppel, I am using now in chronic juvenile arteritis,

left adrenalectomy which has given me results much more satisfactory than operations upon the sympathetic.

4. *Disease of Venous System.*—For the consequences of phlebitis, sympathectomy seems to me to be very frequently indicated, either to be used alone or in addition to the liberation of a vein involved in sclerotic tissue, or the resection of an obliterated venous trunk. I have obtained very favorable results in phlebitic ulcers, in varicose eczema, in the pain and cramps consecutive to old phlebitis.

5. *Œdemas.*—It is quite natural also that one should think of employing the sympathetic operations in the surgical œdemas which supervene in every renal or cardiac affection. Are not these œdemas the evident manifestation of a vasomotor trouble? They comprise the acute traumatic œdema; the œdemas of the lower limbs in consequence of periphlebitis of the pelvic veins; œdemas dependent upon hidden spina bifida.

Acute Traumatic Œdemas have been observed frequently during the late war as well as in the civil practice of accidents. In these I have seen cases of very surprising benefit resulting from sympathectomy. Thus in a railway employee who, five hours after having received the weight of a wagon upon the back of the hand, had developed an enormous œdema with stiffness and paresis of the fingers. In this case the œdema which had persisted notwithstanding the most varied methods of treatment during more than two months, was completely healed four hours after perihumeral sympathectomy and remained so for five years. Analogous results have been recorded by Bianchetti, Wertheimer and myself in two other cases. In œdemas of the lower extremities of spontaneous origin, I think that very frequently a phlebitis of the pelvic veins is the cause and I have in several of these cases uncovered these vessels, resected the obliterated veins and obtained a very appreciable diminution of the œdema. When one has to do with an occult spina bifida, intervention must be made upon the spine and not upon the sympathetic.

6. *Chronic Ulcerations With the Exception of Those of Nervous Origin.*—Chronic ulcers, other than those of nervous origin, occur especially in the lower limb. It is in fact the chapter on ulcers of the leg that I open here. Of these, the most frequent are (a) varicose ulcers; (b) ulcers developing upon old burn cicatrices; (c) ulcers dependent upon phlebitis of the veins of the pelvis; (d) ulcers developing upon an old complicated fracture-callus; (e) ulcers in amputation stumps. These different causes all end finally in the production of a chronic ulceration which has little tendency to heal and recurs with great facility each time that healing has with difficulty been obtained. The cause of the ulcer varies according to its type. There has to be settled the category and the therapeutic indication according to the group with which one has to do; but when the etiological treatment is inaugurated, there remains a problem of ulceration proper of which one does not always take sufficient account. In fact, the treatment of chronic ulcers should always resolve itself into a double problem, that of the cause and that of the

ulcer itself. Since the problem of the ulcer proper is common to all the groups, it is to this that I will first address myself.

Chronic ulcers of the leg are distinguished by their incurability and their great tendency to recur. Why is this so? Why is it so difficult to make heal chronic ulcers of the leg? It has seemed to us, Fontaine and myself, that three causes especially occasion the incurability of these ulcers. There is first the fact that the ulcer is consecutive to a dermoepidermic necrosis springing from an arterial ischæmia, sometimes spasmodic, which creates a positive loss of substance always much greater than the apparent ulceration. The ulcer is incurable because the bad local circulatory conditions lead to an imperfect nutrition of the soft parts where the viability of the tissues is always mediocre. Finally, the deep infection by all kinds of micro-organisms in the surface of the ulcer must be taken into account, an infection which does not disappear even after weeks of rest and varied methods of treatment. Indeed, an ulcer, whether varicose,

FIGS. 1 and 2 show varicose ulcers for which perifemoral sympathectomy was performed. Ten days later skin grafts were applied. Figure 2 shows the ulcers completely healed. The result still persists two and one-half years after the operation.

phlebitic, postphlebitic or due to excessive callus, fails to heal or always recurs because it is seated in the worst conditions of life and repair. This fact, based upon the anatomo-pathological examinations of numerous excised ulcers, has led Fontaine and myself to say that every good method of treatment of chronic ulcers of the leg should involve removal of the causes favoring local recurrence by changing the circulation and the conditions of the skin, by sterilizing the ulcer and by the removal of the cicatricial skin and its replacement by skin of good quality. Now numerous experimental and clinical researches, which the reader will find set forth in the number of the

ANNALS OF SURGERY for November, 1926, have demonstrated that sympathectomy is capable of transforming the terrain upon which an ulcer develops at the same time as it favors its sterilization. An ulcer of the leg is infected by various microbes, among which predominate the staphylo-, strepto-, and micrococcus candicans. The bottom of the wound is grayish and covered with sanies. There is a fibrinous layer within which are enclosed the microbes. Sympathectomy quickly exaggerates the suppuration but by the third or fourth day it has diminished and it is remarkable, after rubbing, to see polymorphonuclear cells re-appear and devour the microbes. At the end of three or four days there are no more free microbes and the fibrinous net-work has disappeared, it is replaced by normal granulation tissue. By the fifth to the eighth day at the soil of the wound, there are only numerous polymorphonuclears in good condition and large normal mononuclears resting upon a normal tissue. Microscopically, the red wound covered with granulations of good quality has lost its aspect of a pathological ulceration tendency and

FIG. 2.—Ulcers completely healed. See Fig. 1.

epidermization appears and the sterile wound is in course of regular repair. In fact, under the conditions of active vasodilatation and phagocytosis, the conditions have been changed from that of a chronic ulcer whilst the afflux of the large mononuclears continues the repair. Thus may be found explained the striking effect of periarterial sympathectomy in chronic ulcers, the rapidity of the changes which it produces in a torpid wound and the quickness of the healing which follows.

This rapidity has been measured with exactness. Jeanneney and Mathey-Cornat have studied it with relation to its oscillometric and thermometric qualities. They have seen that the curve is parallel to the curves of pressure as indicated by the oscillometric index and that of local temperature. Mouchet and Guillemin, also, have shown that the daily coefficient of cicatrization after a sympathectomy was much superior to that following other methods of hyperæmia such as the section of the internal saphenous nerve of Proust and of Nabias. One can say, therefore, that this rapidity of cicatrization seems due to multiple factors, including vasodilatation, sterilization of infected surfaces, modification of the wound field, increased vitality of the tissues. These last words should not be considered as a simple verbalism. The vitality is exalted every time that the circulatory conditions are improved. But if it is certain that periarterial sympathectomy has a very powerful effect upon ulceration, it is not less true that by itself it is not sufficient to maintain the cure. It does not protect from recurrences. For the spontaneous cicatrization which it brings about can produce only a cicatricial tissue of bad quality with epidermis so thin, so glossy and so fragile that a recurrence may follow the least bruise. To prevent this, it is absolutely necessary to substitute for the poor skin a

FIGS. 3–8.—Quadruple varicose ulcers. Figure 3 shows the right external malleolar region. Figure 4 shows the right internal malleolar region. Figure 5 shows the left external malleolar region. Figure 6 shows the left internal malleolar region. Peri-femoral sympathectomy was performed on September 3, 1926; and ten days after skin grafts were applied. Figures 7 and 8, results obtained twenty days after the grafts. In April 1928, patient remains cured.

skin of good quality. In other words, it is necessary to combine cutaneous grafts with periarterial sympathectomy. By this combined method of treatment of ulcers of the leg, I expect from the sympathectomy only such transformation of the nutritive and circulatory conditions of the ulcer as will make out of the chronic atonic ulcer a granulating wound, while it is from the cutaneous grafts I expect final success. So the treatment of ulceration proper consists in periarterial sympathectomy and, at the most favorable moment, that is to say, between the seventh and twelfth days, in the implantation of cutaneous grafts, for which I use, in general, the grafts of Halsted-Davis. This treatment does not take the place in any respect of therapeutis called

for by the cause of the ulcer, as I will show in passing in review the different classes of ulcers of the leg.

Varicose Ulcers.—Many authors class as varicose ulcers every ulcer of the leg which is not frankly syphilitic. Contrary to this conception, I accept as a varicose ulcer only one which is developed upon a base plainly varicose, at the centre of which is a varix. The etiological treatment will be, in such cases, that of varices. I make it a habit at the time of the sympathectomy to add to it a saphenectomy after the manner of Babcock.

Syphilitic Ulcers.—Among ulcers of the leg I think that many are syphilitic, whether a positive Wassermann is absent or the syphilis is unquestionable. In these cases every time then, where there are no plain varices, I always begin by a treatment test whatever may be the laboratory response. I have often seen the ulcer become clean and contract very rapidly. To hasten the cure, I apply Davis grafts as soon as the ulcer is in proper condition.

Aside from true varicose ulcers and from syphilitic ulcers, there remain a certain number whose origin may not be clear. In such cases I content myself with the treatment just described, which is equally applicable to ulcers resulting from old burns. *Ulcerations dependent upon phlebitis of the pelvic veins* are much more frequent than has been thought. I think that in such cases the treatment of the ulcer is less important than the

Fig. 4.—Varicose ulcer, right internal malleolar region.

direct intervention upon the veins of the pelvis. By laparotomy one must verify their presence and resect the obliterated segments. If such intervention does not suffice to bring about cure, one may add then, and then only, that of the ulcer itself. In two cases where I limited the operation to the ulcer without previous laparotomy, I saw rapid recurrence.

Ulcers based upon the callus of an old complicated fracture display the important part which an etiological treatment should take. The skin becomes ulcerated over exuberant callus because over this excessive callus the integument is stretched as upon a rack and its circulation interfered with. To treat such an ulcer without first remedying its origin is to expose it to failure or rapid recurrence. This I have seen twice. In two cases final cure was obtained only when the volume of the callus had been lessened.

In stump ulcers, sympathectomy followed by grafting is certainly the method of choice.

Up to the present time, I have treated twenty-four cases of ulcers of the leg by the combined method, adding to it each time whatever was indicated by the requirements of appropriate etiologic treatment. Among these twenty-four cases, there were fifteen cases of varicose ulcers, all very old, in seven of whom the varices were very marked. Saphenectomy was done as a part of the combined method in these cases. In all the others, I have commenced by precautionary antisyphilitic treatment and I have resorted to sympathectomy only after failure of the antispecific cure. I have applied the same treatment to three cases of ulcers following old burns, to two cases of stump ulcers and to one of chronic ulcer supervening upon an operative cicatrix. In all these cases, the method of a periarterial sympathectomy combined with cutaneous grafts has enabled me to obtain a supple and mobile skin covering the deeper layers. I have no operative failure. Re-seen after a long interval, my patients present skin grafts of good quality possessing all the properties of normal integument which, at the end of some months, is distinguishable from the neighboring skin only by the persistence of a raised surface, although its vascularization and sensibility are normal. Being of good quality, the grafted skin is able to resist external shocks and thus avoid recurrences. Quite lately I have seen again all those operated upon by me, the eldest of

FIG. 5.—Varicose ulcer, left internal malleolar region.

whom dates back to two years or more while the more recent dates back only a few months. I have thus been able to convince myself that the cure obtained is permanent.

In none of these operated patients has recurrence taken place in the grafted zones, although in some recurrence has taken place in the zones of pigmentary dermatitis bordering upon the old ulcer. So in the hope of escaping these recurrences, I have adopted the habit of preceding the grafting of the ulcer by its excision, removing at the same time the entire pigmented zone which surrounds it.

Two conditions may be present; the ulcer and the pigmented zone may be of slight dimensions so that the complete excision into healthy skin may be done. In such cases, the operation brings about a definite cure. Or, the lesions may have an extent too great for an excision to include their whole extent. I excise then as much as I can. It is in these cases that I have observed recurrences.

En résumé, an experience of several years during which I have actively

occupied myself with the treatment of ulcers of the leg has shown me that every ulcer of the leg requires double treatment, that of the ulceration itself and that of the cause of the ulcer. In certain cases, such as ulcers following burns, chronic non-varicose ulcers of the leg, the etiology is nothing, the ulcer is all, the treatment of the ulcer is the first thing. There are other cases such as ulcers caused by exuberant callus and ulcers caused by pelvic phlebitis in which, on the contrary, the etiological treatment takes precedence. There are varicose ulcers finally in which the two ideas are easily and usefully combined. The results of the combined methods of sympathectomy and cutaneous grafts in the treatment of ulcers are very satisfactory in their ultimate state. The skin obtained is supple and of good quality. It prevents recurrences. Certain cure can be obtained only if one combines excision of the ulcer and of the neighboring parts with sympathectomy and cutaneous grafts. When such excision is technically impossible, recurrences in the non-grafted parts are to be feared but by proceeding step by step and by treating these recurrences in the same way, one can finally obtain complete cicatrization.

7. *Ulcerations of Nervous Origin.*—In the

FIG. 6.—Varicose ulcer, left internal malleolar region.

ulcers symptomatic of tabes, syringo-myelia, myelitis or spina bifida, I think that sympathectomy is contraindicated notwithstanding the results published by Mathey-Cornat. I have never resorted to it in these conditions. Likewise, I do not think that the perforating plantar ulcer should be retained as an indication for sympathetic interference. On the other hand, in trophic ulcerations following spinal cord injuries, Bardon and Mathey-Cornat, Brunning and I, myself, have obtained very evident benefit. In the chronic ulcers consecutive to wounds of great nerve trunks, periarterial sympathectomy has often been employed. I think that in these cases the trophic troubles are produced only when there is a neuroma of the proximal end of the cut nerve. The true prophylaxis and the best treatment of these cases of ulceration consist in the repair as soon as possible of the nerve by direct suture or by grafts after having replaced the foot in good position by such orthopedic intervention as may be called for. If, nevertheless, ulcers follow or fail to heal, sympathectomy may be resorted to. Like Stahl, and like Villardel, I have observed in such cases rapid cures, lasting for four years and more. So also, in ulcerated stumps where certainly sympathectomies have given brilliant

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successes, I combine sympathectomy with excision of the ulcer followed by the application of cutaneous grafts.

8. *The Ischæmic Contracture of Volkmann.*—Volkmann's syndrome is very frequently the result of an arterial traumatic contusion which has been followed by thrombosis, sometimes even with rupture and hemorrhage. The ischæmic necrosis is dependent directly upon such injury and the consecutive sympathetic troubles accentuate still more the vasomotor phenomena. In such cases there takes place, moreover, very rapid advance which can be explained only by irritation of the periarterial sympathetic plexuses. In cases of arterial thrombosis, the treatment of choice will be the resection of the obliterated segment. I have done this twice, once in a little girl six years of age and once in a boy of ten years, both of whom had a fracture of the elbow which had been treated in strong flexion with a plaster apparatus; the syndrome of Volkmann appeared soon after the immobilization. In both these cases there was found complete arterial obliteration and in both, resection of these segments restored to the muscles of the forearm complete mobility. (Figs. 9, 10 and 11.) In the same way, I have operated upon acute cases of Volkmann's syndrome supervening upon muscular wounds of the forearm. In these cases the perihumeral sympathectomy was followed by a rapid cessation of the arterial spasm, restoring the integrity of motion.

FIG. 7.—Results obtained in varicose ulcers after perifemoral sympathectomy followed by skin grafting. Photo taken twenty days after the grafting.

9. *Diseases of Bones and Joints.*—It seems to me that in the diseases of bones and joints, sympathectomy may find multiple indications. One may consider sympathetic operations in delayed consolidation; in osteo-articular tuberculoses; in osteoporosis and in traumatic arthritis.

a. *Delayed Consolidation.*—From the researches which I have undertaken with Professor Policard, it has been established that vasomotor phenomena play a very important rôle in ossification and in consolidation of fractures. If, for one reason or another, the hyperemia which presides over ossification, and which regulates modifications of connective tissue and local

changes in calcification, should be interfered with before the end of the processes of repair, delay of consolidation follows. It was, therefore, logical to try to influence such delays in consolidation by a periarterial sympathectomy.

Experimentally, Uffreduzzi and his pupils Mariano and Palma, have proved that the rapidity of ossification is accelerated after sympathectomy. In my own laboratory, Fontaine came to the same conclusions by making upon rabbits and dogs identical fractures on both sides. In such cases, we have always observed, Fontaine and myself, that consolidation was much more rapid on the sympathectomized side. The more recent experiments of Professor Gaudier speak in the same way. In man, Cotte, Uffreduzzi, Kappis, Roubachoff and Stropeni as well as Gaudier and Estor, have established the good effects of sympathectomy in the consolidation of recent fractures and in cases of delayed consolidation. It is evident that sympathectomy does not act when one has to do with a true pseudarthrosis due to fibrous or muscular interposition. Personally, I have twice resorted to sympathectomy in recent fractures and eleven times in cases of delayed consolidation and secondary resorption of callus or pseudarthrosis after failure of bony union. In four cases, I obtained no result; in one case, the patient was lost sight of; in six other cases the fractures healed very rapidly after the sympathectomy. This, then, appears to me always indicated in delayed

Fig. 8.—Same as Fig. 7.

consolidation when one is sure that there is no true pseudarthrosis present.

b. *In Osteo-articular Tuberculoses* sympathectomy has been tried by Floresco and later by Gundermann, Laewen, Sebestyen, etc. Callandra and Bertoni have operated in such cases and in Russia a certain number of observations have been published. Six cases of osteo-articular tuberculosis, in which I performed sympathectomy, were reported by Fontaine in 1925, and since then I have operated upon five others. The balance sheet in osteo-articular tuberculoses is unsatisfactory, although there exist indisputable cases in which such intervention has had a very notable result. It seems to me, according to my own personal experience and in accordance with what I have gathered from reading published cases, that the better results have been obtained in cases attended with fistulæ and with elimination of numerous

Fig. 9.—Ischæmic Contracture of Volkmann. Position of the left upper extremity day before the operation.

Fig. 10.—Extension of the wrist. In this position complete extension of the fingers is impossible.

FIG. 11.—Result obtained nine months after the operation. The extension of the fingers is normal with the exception of the second interphalangeal joint of the index finger.
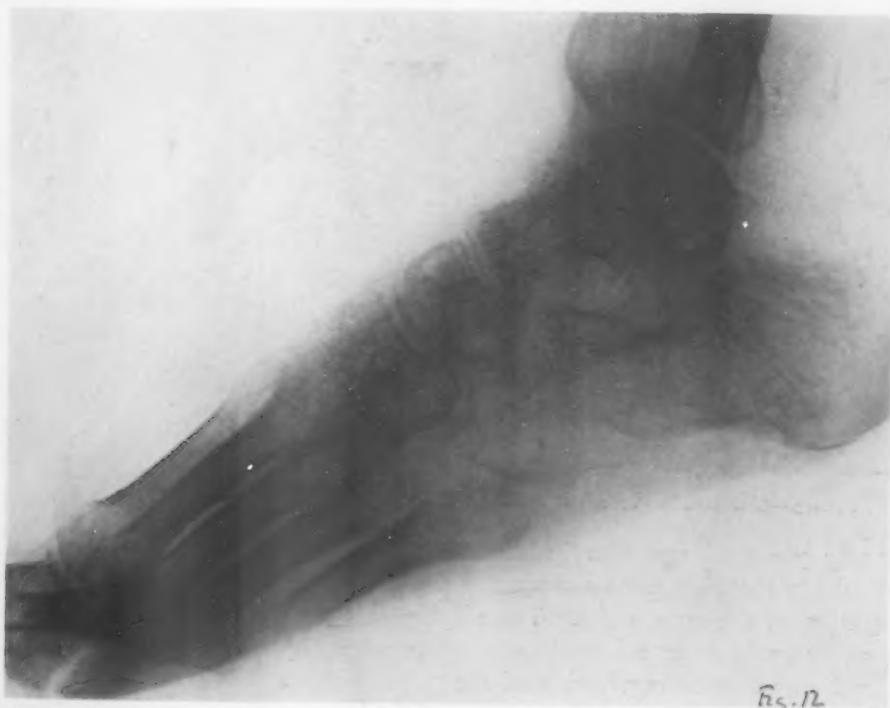

FIG. 12.—Osteoporosis of bones of left foot after severe trauma. Patient has been in bed one year. Left lumbar ramisection was performed on November 26, 1926. The pain disappeared instantaneously. Sixteen days later the patient began to walk. Three and one-half months after the operation the bones of the left foot were completely recalcified. (See Fig. 13.)

sequestra, which is often followed by rapid ankylosis. I have also observed some surprising results in white swellings of the wrist. In these later cases the reservation should be made that many cases of so-called tuberculosis of the wrist are really only cases of traumatic osteoporosis.

c. *Osteoporosis and Traumatic Arthritis.*—The osteoporoses of traumatic origin are much more frequent than one would think. They ought to be better known. When in 1924 I came to Strasbourg, I was shown a patient

FIG. 13.—Osteoporosis. Three and one-half months after lumbar ramisection. (See Fig. 12.)

twenty years of age who had been already under treatment for several months in the clinic for an extremely painful swelling with complete loss of function of the right wrist. These symptoms had supervened some weeks after an accident in his work, producing strong hyperflexion of the wrist. The X-ray showed rarefaction of the carpal bones and it seemed that there existed a focus of bacillus infection in the middle of the os magnum. Notwithstanding this patient had been immobilized in plaster already for several months, he continued to suffer.

In December, 1924, I made a perihumeral sympathectomy without tak-

ing the hand out of the plaster. In a very few days the œdema had disappeared, the wrist became painless and two months later all trace of swelling had disappeared and the patient had regained all movements of his wrist. The X-ray view of the bonelets showed them re-calcified. In retrospect I was able to make the diagnosis of traumatic osteoporosis. These cases are less rare than has been thought. I have observed several of them. All have been presented to me as cases of tuberculosis of the wrist or of the tarsus.
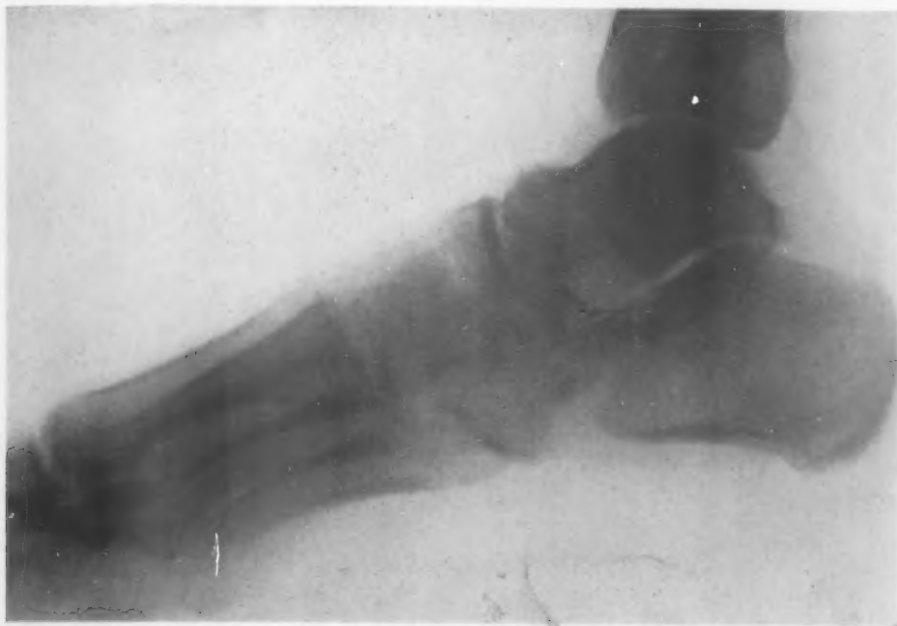

Fig. 14.—Osteoporosis of bones of foot after a slight trauma of the foot several months previous. The X-ray showed a very marked degree of decalcification of all the bones of the foot. Perifemoral sympathectomy was performed on November 26, 1926. The pain disappeared immediately and two months later a new X-ray (Fig. 15) showed a nearly complete recalcification of the bones.

Sympathectomy is very efficient against osteoporosis: the pain ceases in a very few days, the swelling disappears and the patient regains full motion. I consider, even at the present time, traumatic osteoporosis as one of the most favorable indications for sympathectomy. Osteoporosis may occur in any of the bones. It affects especially the tarsus and the carpus. Anatomically, it produces an hyperæmic rarefaction of the bone which becomes porous. In an epiphysis this rarefaction may bring about detachment of the diarthrodial cartilage with a resulting traumatic arthritis. Traumatic arthritis and osteoporosis are then phenomena of similar nature, to be distinguished only by their seat, whether epiphyseal or diaphyseal. They are the consequence of the reflexes of the torn axons attending traumatisms which involve the articular and periarticular regions. The disturbance of these regions, ever rich in nerves, suffices to provoke instantly a very important modification of the local circulation of the limbs as has been shown by my pupils, Fontaine and Miloyewitch. The complex character of the articulation of the tarsus and of the

carpus explains the frequency of such poroses of the wrist and of the foot. They yield always to operations upon the sympathetic.

Traumatic arthritis is observed most frequently in the shoulder and the knee. For the lesions of the shoulder, I practice perisubclavicular sym-

FIG. 15.—Condition of bones in case of osteoporosis two months after perifemoral sympathectomy in person of patient shown in Fig. 14.

pathectomy. For the traumatic arthritis of the knee, I betake myself, according to the case, to perifemoral sympathectomy. To perisubclavicular sympathectomy, I owe, in the treatment of traumatic arthritis, two successes with almost complete functional recovery of all the movements of the shoulder.[3]

*   *   *   *   *

From the exposé which I have just made, it results that operations upon the sympathetic already possess very many indications, but I can never emphasize too strongly that in order to give successes such intervention should not be employed carelessly. They do not constitute methods of random treatment

[3] Leriche: Mècanisme des hydarthroses et des arthrites traumatiques. *Soc. de Chirurgie de Lyon*, 8 dècembre, 1927, in *Lyon Chirurgical*, Tome xxv, No. 2, 1928, p. 225.

as certain surgeons would have wished to do with them, but, based upon precise physiology as we begin to see, they have indications not less precise. I have reported those which have appeared to me at the actual moment the clearest.

One word in conclusion. When is it necessary to employ periarterial sympathectomy? When is it necessary to practice the intervention upon the sympathetic chain itself and when is it better to attack communicating branches?

The physiological researches which I have undertaken with Fontaine and which will appear *en résumé* in a near number of *Surgery, Gynæcology and Obstetrics,* will have arrived at the following conclusions:

Intervention upon the chain itself, the division of communicating branches, and periarterial sympathectomy have all three the same influence upon circulation. There exist between the circulatory modification of periarterial sympathectomy and those which one sees after intervention upon the chain or sections of the communicating branches, only quantitative differences, not qualitative. They are less marked in the first case than in the second.

Interventions upon the sympathetic chain have many inconveniences in as much as they often expose to serious post-operative trouble.

Preferably, therefore, it is to intervention upon the periarterial sympathetic or the sections of the communicating branches that one should resort. Of these two kinds of intervention, one should choose ramisection every time when one wishes to obtain a strong effect or when one has to do with lesions of long duration. In all other cases, it is periarterial sympathectomy that one should always try in the first place for, besides its therapeutic efficiency, it adds simplicity of execution.

CLINICAL STUDIES OF ADRENALECTOMY AND SYMPATHECTOMY

By George W. Crile, M.D.

of Cleveland, Ohio

Fourteen years ago in an attempt to apply principles which were first enunciated in an Ether Day address in the Massachusetts General Hospital in 1910, I began a series of operations in which adrenalectomy was either performed alone or was combined with sympathectomy or with thyroidectomy or with both, in an attempt to control certain diseases by lessening what at that time I first termed the "kinetic drive". The aim was to devise a general plan of reducing certain activities with no pretense of the actual cause —a broadened conception of the operation for hyperthyroidism. Twenty-nine such operations have now been performed—sympathectomy alone in two cases; adrenalectomy alone in twelve cases; adrenalectomy and thyroidectomy in five cases; adrenalectomy, thyroidectomy and sympathectomy in eight cases; adrenalectomy, ligation and sympathectomy in two cases.

These operations have been performed for the following conditions: (1) Epilepsy, (2) neurasthenia, (3) hypertension, (4) endarteritis obliterans, and (5) hyperthyroidism and hypertension.

Epilepsy.—Thirteen operations have been performed for epilepsy—sympathectomy in one case; adrenalectomy in four cases; adrenalectomy, ligation and sympathectomy in two cases; adrenalectomy and thyroidectomy in one case; adrenalectomy, thyroidectomy and sympathectomy in five cases. All but one, the first in this series to be performed, were undertaken in the belief that the enormous discharge of energy manifested in epileptic convulsions might be dependent either upon the adrenal output alone or upon the interaction of the adrenals and the thyroid gland. It is not necessary at this time to review the effect upon the organism as a whole, of the total removal of the adrenals or of the thyroid. It is well known that in either case the brain becomes incapable of normal action and that the animal becomes adynamic.

A study of the end results in this group of cases shows that adrenalectomy by itself is practically without effect; the combination of adrenalectomy, thyroidectomy and sympathectomy, however, has modified the course of the disease in certain cases. One patient reported five and a half years after operation that the attacks occurred only "two-thirds as often and were one-third as severe" as before operation. Another reported four years after operation that his attacks, which before operation had occurred several times in a day, occurred only at intervals of two months or more, he had no digestive trouble, felt very much improved, had gained weight, and was able to work every day. This patient reported again, eight years after his

operation, that he still felt much better than before operation although the attacks were occurring twice a week; but they lasted for two or three minutes only and occurred at night, so that he was able to continue at work. In another case, before operation the attacks came almost daily; two years after the operation the average interval between the attacks was six months. Seven years afterward this patient had attacks only in March, August, and September. In one other case the patient, who has lived for thirteen years since operation, has had no attacks for eleven years. Four, therefore, out of the five cases of epilepsy in which adrenalectomy, thyroidectomy and sympathectomy were performed have shown definite improvement, and one of these patients is completely cured.

Neurasthenia.—In 1917, four operations were performed in cases of neurasthemia. The operation which we might term "dekineticization" was performed in the belief that since the brain is sensitized by the adrenals and the thyroid it can be desensitized by reducing the activity of these two organs. In one of these cases the patient was not improved. In another the patient reported one year after operation that he was unimproved; but later it was learned that for fourteen months he had been employed in an ammunition train of the A.E.F. Since before operation he had been unable to exert himself for even a half day without becoming completely exhausted, and for six months had made no attempt to do hard labor, we may conclude that whatever his subjective feelings, his physical condition was improved. Whether or not that was due to the psychic effect of the war or to the operation must remain *sub judice*. In another case of neurasthenia the patient had been on prolonged medical treatment, was very weak, had tachycardia, insomnia, and gastro-intestinal disturbances which were manifested by nausea, vomiting, attacks of dizziness, and severe epigastric pains. The patient left the hospital in an improved condition and a grateful letter received eight months later, although it does not specifically refer to the patient's condition, would never have been written in the presence of the old symptoms. It has not been possible to trace this patient for a further report. In another case the immediate result as entered upon the operative report was that the patient was "well". Six months later a report from the patient's physician read as follows: "There is no sweating of the hands or feet and he has lost his tremor, his heart action is practically normal, and his pulse is 80 after he ascends a flight of stairs. He is dressing tools for drilling oil wells, which is very heavy work. He is making a very remarkable recovery." In this case adrenalectomy, thyroidectomy and sympathectomy were performed.

We feel that in this group of cases the results must be considered inconclusive.

Cardiovascular Disease.—This series includes three cases of endarteritis obliterans and five of hypertension. The phenomena of endarteritis obliterans in its early stages and the known etiology of arteriosclerosis suggested that "dekineticization" might be effective in the treatment of these conditions.

In this whole group of cases, however, the results have been practically negligible. In every case of hypertension there was an immediate effect upon the blood pressure; however, it soon regained and retained its high elevation, while in the cases of endarteritis obliterans the disease continued to progress.

Hyperthryoidism and Hypertension.—Clinical and experimental investigations have appeared to indicate that the specific agent which causes the acute exacerbations of hyperthyroidism is adrenalin. It is a common clinical observation that only such factors as cause an increased output of adrenalin can cause the specific excitation which is called a thyroid crisis; and on the other hand, we have found that the factors and agencies that either mitigate or have no effect on thyroid crises have no power to increase the output of adrenalin.

We know that in the list of classical symptoms in the syndrome of hyperthyroidism, increased pulse rate, blood pressure and increased heart rate occupy a leading place. We know that the secretion of the thyroid gland sensitizes the tissues to adrenalin and that as the thyroid secretion is decreased the response of the tissues to adrenalin is correspondingly decreased; in other words, the acute crisis of hyperthyroidism may be called an adrenalism crisis and adrenalism can be produced only on the background of previously increased thyroid activity. Time is lacking to offer the wealth of experimental and clinical data which support this postulate. If our conception of the rôle of the adrenals and the thyroid is correct, then by removing one adrenal gland in cases of hyperthyroidism the factor of safety of the patient should be increased; that is, the removal of one adrenal like the removal of one-half of the thyroid gland should reduce the phenomena of hyperthyroidism. We have, therefore, performed this operation in four cases—adrenalectomy alone in three cases, and adrenalectomy and thyroidectomy in one case. In each case there was an immediate but not permanent effect upon the hypertension and in every case the basal metabolism was reduced. In one the basal metabolism fell at once from plus twenty-nine to plus seven and five months after operation it was still plus five. In another the patient came in with a record of a basal metabolism rate of plus forty, two weeks after operation it was plus eleven and four months after operation it was minus four per cent. In another the patient entered the hospital with a basal metabolism rate of plus twenty—leaving with minus two. In three cases in which the thyroid gland was not removed the gland diminished in size and grew firm in texture; and of equal significance, although the operation was much more severe and of longer duration than a thyroidectomy, there was but little post-operative reaction, that is, little so-called post-operative hyperthyroidism.

These operations have been performed too recently for the results to be considered as end results. This is offered only as a temporary report.

For adrenalectomy the patient is placed in the "kidney position" and a left oblique lumbar incision is made, the incision being carried down through

the subcutaneous tissues and muscles to the kidney. A bloodless field is maintained throughout the operation and long instruments and flexible retractors are employed. When the kidney is reached the perirenal fat is detached from the upper pole, and the adrenal gland can then usually be readily identified by palpation and by observation of its specific yellow color. The adrenal artery is extraordinarily large.

There is usually a marked fall in the blood pressure during and immediately after operation—this lasts for some hours, sometimes for days, and it is a curious observation that the fall is greater at the radial pulse on the side on which the operation is performed. We have not observed any pigmentary change in any case and the removal of a single gland apparently does not even approach the margin of safety.

Excision of the cervical sympathetic is made through the usual collar incision employed for thyroidectomy. The carotid sheath is divided on each side, the cervical sympathetic nerve being identified without difficulty.

There has been no operative mortality in any of these groups of cases.

SUMMARY

Twenty-nine cases are reported in which an attempt has been made to treat certain diseases which are apparently related to adrenal activity by adrenalectomy alone, by adrenalectomy associated with thyroidectomy and sympathectomy, or by sympathectomy alone (in two cases).

This series includes thirteen cases of epilepsy, four cases of neurasthenia, three cases of endarteritis obliterans, five cases of hypertension, four cases of hyperthyroidism with hypertension.

The results of the treatment of endarteritis obliterans and of hypertension were negligible, and they were inconclusive as far as the treatment of neurasthenia is concerned. The results of the combined operations in cases of epilepsy are hopeful. The end results of the treatment of hyperthyroidism by adrenalectomy cannot yet be given but the early results show marked improvement.

END RESULTS OF PERIARTERIAL SYMPATHECTOMY

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In 1913, Leriche called our attention to this procedure and in 1921, before this Association, he reported the results in 64 operations. His papers and those of his pupils have been very numerous and have stimulated the greatest interest in the peripheral sympathetic nervous system, rather dormant from the standpoint of practical surgery except for the work on the cervical sympathetics by Jaboulay, Jonnesco and others. Briefly, periarterial sympathectomy is done to effect a temporary vasodilatation of the peripheral circulation distal to the point of operation. Apparently it exerts some trophic influence on the tissues as well and there is evidence to show that sometimes an effect is exerted other than on the arterial tree manipulated. The effect on sensory relations is also positive but imperfectly understood. A great deal of controversy has arisen as to its mode of action and some have denied that it could have any effect but Leriche has brought forward much proof and in a recent paper (1927), believes that the classical ideas of the pathways of vasomotor impulses must give way to the belief that intramural peripheral centres are essential for the control of the circulation. I am unable to venture any opinion on the probability of his suggestion.

The reports in the literature vary from the recording of utter failure to miraculous cures and apparently something in the individual case determines the result, something which we are unable to foresee or predict. Many of the operations have been done without possibility of good result and some surgeons have condemned the operation on the basis of failure in a poorly selected group of cases. I have thought it worth while to record my experience based on ninety operations on seventy-two patients. The percentage of failure has been high, but in a few cases the result has been so satisfactory as to make the venture worth while. The variety of diseases for which the operation has been undertaken covers a wide range but certain groups can be established.

Table I.

Total of Patients. Periarterial Sympathectomy.

December, 1919–March, 1928. 90 operations, 72 patients.

Disease	Cases	Relieved
Thrombo-angiitis obliterans	17	2
Arteriosclerotic gangrene (senile and diabetic)	12*	2
Raynaud's disease	3	2
Scleroderma	3	0
Trophic ulcer	10	6
Leg ulcer	7	5
Painful stump	4	2
Miscellaneous	16	6

72 patients, 25 successful (34.7 per cent.).

* One death (1.4 per cent.).

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Arteriosclerosis with Gangrene.—Periarterial sympathectomy seems to have been practiced many times for the relief of the pain, and in the hope of checking the gangrene in the senile type of gangrene and in the diabetic. In my own experience there is no warrant for the operation except possibly for one indication. Sometimes an arteriosclerotic extremity is painful and the foot is cyanotic but gangrene has not developed. The case is apt to resemble Buerger's disease but other signs are lacking. Buerger has described such cases under the term vasoneurosis with organic arterial disease. He believes that the tip gangrene may be the result of a vasomotor neurosis independent of the obliterated main vessels. I have ascribed the recovery in one case to the action of the sympathectomy but Buerger suggests that, "following or without the use of the Leriche operation of decortication of the femoral artery, but aided by detachment of the dead epidermis and multiple puncture of the exposed corium, gradual restitution takes place."

Sympathectomy has usually relieved pain to a considerable degree in early cases of this type but I do not believe that it checked the gangrene in any case. The same may be said of the diabetic foot. In one case sympathectomy relieved pain and partial amputation of the toe was followed by recovery but Stetten a few years ago showed an excellent series of results from conservative measures alone. In arteriosclerosis the operation is supposed to be indicated on the basis of a spasm in the collaterals due to the irritation of the gangrene which is superimposed on the mechanical obstacle. I believe that if the sympathectomy is done in these cases we should also ligate the artery as proposed by Dean Lewis.

Thrombo-angiitis Obliterans.—Buerger's disease is well known but it is well to recall that the essential lesion is an occlusive thrombosis of the arteries and veins. Beginning as an acute process a stage is reached after a time in which the clot is organized and canalized, and there is development of fibrotic tissue in the adventitia that binds together the artery, vein and nerves. The intense rubor with the foot dependent is due to the occluded artery but gangrene is postponed by reason of the collateral circulation which easily develops in young individuals. Pain is the predominant symptom and no doubt is due partly to the neuritis induced by the stagnation of metabolic products and partly to the neuritis from the periarterial inflammation.

I do not see how it is possible to effect any vasodilatation in these vessels by sympathectomy, and unless the dorsalis pedis pulse is patent I believe the operation is useless for this purpose. The suggestion of Dean Lewis to ligate the superficial femoral so as to force and increase the collateral circulation has a better basis. After a fair experience in the treatment of this disease with hypertonic saline injections, sympathectomy and, lately, with typhoid vaccine I do not believe that any treatment makes an appreciable improvement in the peripheral circulation. On the other hand all of them do something for the relief of pain and if this can be accomplished the amputation is postponed. Silbert finds that 77 per cent. come to amputation within

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five years from the onset of symptoms and he deprecates the advocacy of any treatment which claims cure after an insufficient time has elapsed.

Fifteen cases of Buerger's disease have been subjected to sympathectomy. If permanent relief of pain and maintenance of the integrity of the limbs be accepted as criteria for cure we have had only two successful results. In most cases temporary relief of pain was obtained but relapse occurred after a few weeks or the oncoming gangrene necessitated amputation. In one patient sympathectomy was done at the time of amputation through the leg below the knee and the stump healed perfectly.

TABLE II.

Thrombosis and Gangrene—Buerger's, Senile, Diabetic.

Cases	Relieved	Per cent.
29	4	13.8

1. Typical Buerger's. Gangrene toe.   Well 2 years later.
2. Typical Buerger's. Early.   Well 6 years later.
3. Diabetic gangrene toe.   Well 2 years later.
4. Arteriosclerosis. Erythromelalgia.   Well 1 year later.

Raynaud's Disease is supposedly a disturbance of the vasomotor mechanism in which gangrene is a terminal phenomenon. The essential features of the disease are well known and need not be repeated here. Many cases of supposed Raynaud's disease are really Buerger's disease. A number of successes and an equal number of failures have followed sympathectomy and one can theorize for or against the operation. Two of the three cases reported in this series have done well although the period of observation, six months, in one was very short. In the other, six years has elapsed and she is still well.

Scleroderma, in which the lesion was in the hands, seemed to indicate a try at brachial sympathectomy but nothing was attained except that in one case the patient seemed to improve for a number of months only to relapse.

Trophic Ulcer.—Refractory ulceration, probably due in most instances to trophic influences, has furnished a fertile field for this operation, and in those series of cases reported after a short interval the incidence of cure is high but after a time many will be found to relapse.

TABLE III.

Trophic Ulcer. Periarterial Sympathectomy.

Following:	Cases	Relieved
Frost bite	2	1
X-ray burn	1	0
Radium burn	1	0
Trauma	3	3
Multiple neuritis	1	1
Hemiplegia	1	0
Spina bifida	1	1

10 cases, 6 successful (60 per cent.).

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The rationale of the operation is based on the fact that irritative nerve lesions can produce changes in the walls of the arteries supplied by the affected nerves. Hyperemia and trophic influences are the factors affecting the ulcer. It is necessary to remove, if possible, the irritative focus in order to get an effect from sympathectomy. A fairly wide excision of the ulcer, excision of a neuroma, plastic work on scars, etc., must accompany the sympathectomy.

In one of my cases, an ulcer of the heel secondary to a leg laceration, recurrence occurred after two and a half years, with immediate healing after excision of the scar, since which time, three years ago, the ulcer has not recurred. The frost bite ulcer has been well for one year, the spina bifida case with ulcer on the foot, existing for four years, has been well for fifteen months.

The leg ulcers were of the varicose type in six instances and five were cured by sympathectomy, excision of the ulcer and skin grafting. Perhaps the sympathectomy could have been omitted but I feel that it influenced the quick healing and permanent results. One syphilitic ulcer was refractory. The painful stumps gave 50 per cent. of success. It is best to combine a stump trimming if the end is conical, and if a neuroma is suspected I cut the sciatic nerve just above the popliteal space and dissect out the distal end bearing the neuroma.

TABLE IV.

Miscellaneous. Periarterial Sympathectomy.

For :	Cases	Relieved
Cervical rib	I	I
Causalgia	3	0
"Thermalgia"	2	I
Arthritis deformans	2	I
Painful osteoperiostitis	I	I
Intermittent claudication	I	0
Painful scar	I	0
Œdema and phlebitis	I	0
Trophic œdema, hands	I	0
Eczema, hand	I	I
Trophic contractures	I	I
Arterial thrombosis	I	0

16 patients, 6 successful (37.5 per cent.).

Miscellaneous.—In the literature the lesions considered as indications for this operation are almost innumerable. In this series a successful outcome was obtained in six cases, all of extreme interest. The patient with cervical rib suffered from attacks of cold, cyanotic fingers followed by tip gangrene and pain. Sympathectomy effected complete relief of pain and improvement in the circulation. One week later I removed the cervical rib. His fingers healed and he is now perfectly well, nearly seven years since the operation. The case termed "Thermalgia" was most interesting, but will be detailed in the paper. The arthritis deformans patient was a physician, bedridden with almost universal involvement of his joints. He suffered

from severe pain in the feet and had a chronic paronychia in several toes. Sympathectomy was done one side and the relief was so great that he insisted upon having the operation done on the other sides. He remained free from pain and with healed toes until his death one year later. The bone case suffered from pains in the leg as a result of an old chronic osteoperiostitis. Sympathectomy gave permanent relief. The fifth successful case in this group had an eczema of the hands of long duration. The operation cured him and he remained cured up to the time of his death from an œsophageal lesion about four years later. The trophic contractures occurred in a baseball player who ascribed them to the effect of his baseball shoes. There was an element of neurosis in this case but the operation resulted in normal feet and apparent cure after two years.

In this brief review no attempt has been made to cover the subject completely. The operation has given an impetus to the study of the sympathetic nervous system and for this one should be grateful to Leriche. Whether or not the operation will stand the test of time is uncertain. Cervical and lumbar ramisection are being advanced for Raynaud's disease and for thrombo-angiitis obliterans. However, I believe that for the various refractory ulcers of the extremities, particularly those having trophic influence, the operation will prove useful and at any rate it is relatively harmless and easily performed under local anæsthesia. Certainly, some brilliant cures have been obtained and many of the failures can be attributed to faulty selection or a failure to remove the irritating lesion.

LUMBAR SYMPATHETIC GANGLIONECTOMY AND RAMISECTOMY FOR CONGENITAL IDIOPATHIC DILATATION OF THE COLON

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AND

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FROM THE MAYO CLINIC

THE results obtained from lumbar sympathetic ganglionectomy and ramisectomy in the treatment of two patients suffering from congenital idiopathic dilatation of the colon has prompted this report. The terms megacolon, giant-colon, achalasia of the rectum, and congenital idiopathic dilatation of the colon (Hirschsprung's disease) are insufficient to describe the character of the disease. Megacolon has come to mean a dilated hypertrophied colon resulting from some interference with the normal peristaltic function, but does not indicate whether it is of mechanical or neurogenic origin. Since the advanced degrees of each type will probably require different operative procedures, a more accurate classification will be necessary.

Because of the difficulty in many cases of demonstrating mechanical obstruction, at the time of the abdominal exploration, it is fair to assume that the coördinating mechanism of the rectum and sphincter has been disturbed [1, 2, 4, 6, 12, 13, 19, 22, 24], and if similar results are accomplished by operations on the lumbar sympathetic trunk a word or phrase should be coined to describe this group of patients.

We believe that congenital megacolon, and megacolon acquired in early life, without obvious mechanical obstruction, are due to hyperactivity of the sympathetic innervation of the rectum, since one is unable to demonstrate any mechanical block in the rectum or anus, and since there is a dual innervation of the rectum and anus with parasympathetic and sympathetic fibres. The motor impulses to the longitudinal muscle fibres of the rectum are supplied by the parasympathetic and the motor impulses to the circular muscles of the rectum are supplied by the sympathetic, partially arising from the lumbar rami communicantes, passing down through the sympathetic trunks, the hypogastric, and the pelvic plexuses. It is impossible to determine whether this hyperactivity is due to an irritating lesion of the ganglia of the post-ganglionic or the preganglionic fibres, or is of central origin; in all probability it is of central origin.

REPORT OF CASES

CASE I.—A boy, aged eleven months, was admitted to the Section on Pediatrics of the Mayo Clinic, June 16, 1926. At birth, he weighed eight pounds. He was breast-fed for three or four days only and was then placed on various kinds of modified milk.

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The mother said he had been more or less constipated from birth, with attacks of diarrhœa every two or three weeks alternating with periods of freedom from diarrhœa. On admission he was underweight and undernourished. His weight was 6.8 kg.; his height was 67.5 cm.

The child was pale, and the general musculature was poorly developed. The abdomen was a typical "pot belly" type; the intestines were distended with feces and gas. Neither the spleen nor the liver could be palpated. He had seven teeth. The cervical lymph-nodes were slightly enlarged. Further investigation into the history disclosed that the mother had noticed that the child's abdomen had been distended from birth, but she had been unable to interest physicians in the condition, even though it was necessary to give enemas almost every day, besides liquid petrolatum and cathartics in order to move the bowels.

The child was placed in the hospital on forced feeding, physiologic sodium chloride solution subcutaneously and five drops of tincture of belladonna by rectum three times a day. Several bowel movements of clay-colored fluid stools followed. A transfusion of 120 c.c. of blood was given June 22. A consultant advised continuation of the enemas and forced feeding, believing that the child's condition did not warrant ileosigmoidostomy at that time, although he might be able to withstand ileostomy. When he was dismissed, at the end of three weeks, he was considerably improved, and the abdomen was smaller. Instructions were given to the mother with reference to feeding, medication, and bowel irrigation.

In October, 1926, the mother reported that the child was losing weight, that his color was poor, and that enemas failed to produce the desired result. She was instructed to bring him back to the clinic for further observation and treatment which she did May 27, 1927. She said that after their return home in July, 1926, the child had improved for about two months on the feeding of reinforced milk and the two enemas daily. At the expiration of that time, difficulty with the bowels again developed. In September, the local phy-

FIG. 1.—(Case II). Left anterolateral view of a child, aged six years, with congenital idiopathic dilatation of the colon prior to bilateral lumbar sympathetic ganglionectomy and ramisectomy.

sician was obliged to remove an impaction, following which enemas were again given. For a time, between the months of February and May, 1927, the bowels moved normally but in May, 1927, from two to three enemas were given daily, in an effort to secure a bowel movement, when these, too, proved futile, and it became necessary for the physician

to remove the feces with an instrument four or five times during the two or three weeks previous to readmission. Just prior to admission there appeared to be more distention from gas, and peristaltic waves were visible through the abdominal wall. Enemas caused gas to escape but not stools. The abdomen increased from 52.5 to 67.5 cm. in circumference.

The child was very much better nourished than on the first admission; however, the abdomen was markedly enlarged, and peristaltic waves were visible. Rectal examination was made with ease and was negative. Röntgenograms showed dilatation of the descending colon and sigmoid. The specific gravity of the urine was 1.016; it was acid in reaction, sugar was not present, but an occasional pus cell was found. The hæmoglobin was 61 per cent. Erythrocytes numbered 3,940,000 and the leukocytes 8,500; the color index was 0.7. A differential count showed lymphocytes 64.5 per cent., neutrophils 29.5 per cent., large morphonuclear lymphocytes 0.5 per cent., transitional cells 1.5 per cent., eosinophils 2.5 per cent. and basophils 1.5 per cent.

It was obvious that the child was suffering from congenital idiopathic dilatation of the colon, involving chiefly the sigmoid and the descending colon. While he could be kept moderately comfortable on active treatment in the form of feedings of reinforced milk, and the use of enemas of oil, physiologic sodium chloride, and soapsuds, the moment this stringent program was modified mechanical aid was necessary to effect evacuation. In view of this, the child was prepared for surgical treatment. On June 7, 1927, one of us (Adson) performed left lumbar sympathetic

FIG. 2.—Anterior view of patient shown in Figure 1.

ganglionectomy and ramisectomy. The second, third, and fourth lumbar ganglia with the sympathetic chain were removed (the ganglia in one strip), all of the rami coming to and from the ganglia were divided and the sympathetic trunk with the ganglia from just below the first lumbar ganglion to a point below the fourth lumbar ganglion removed
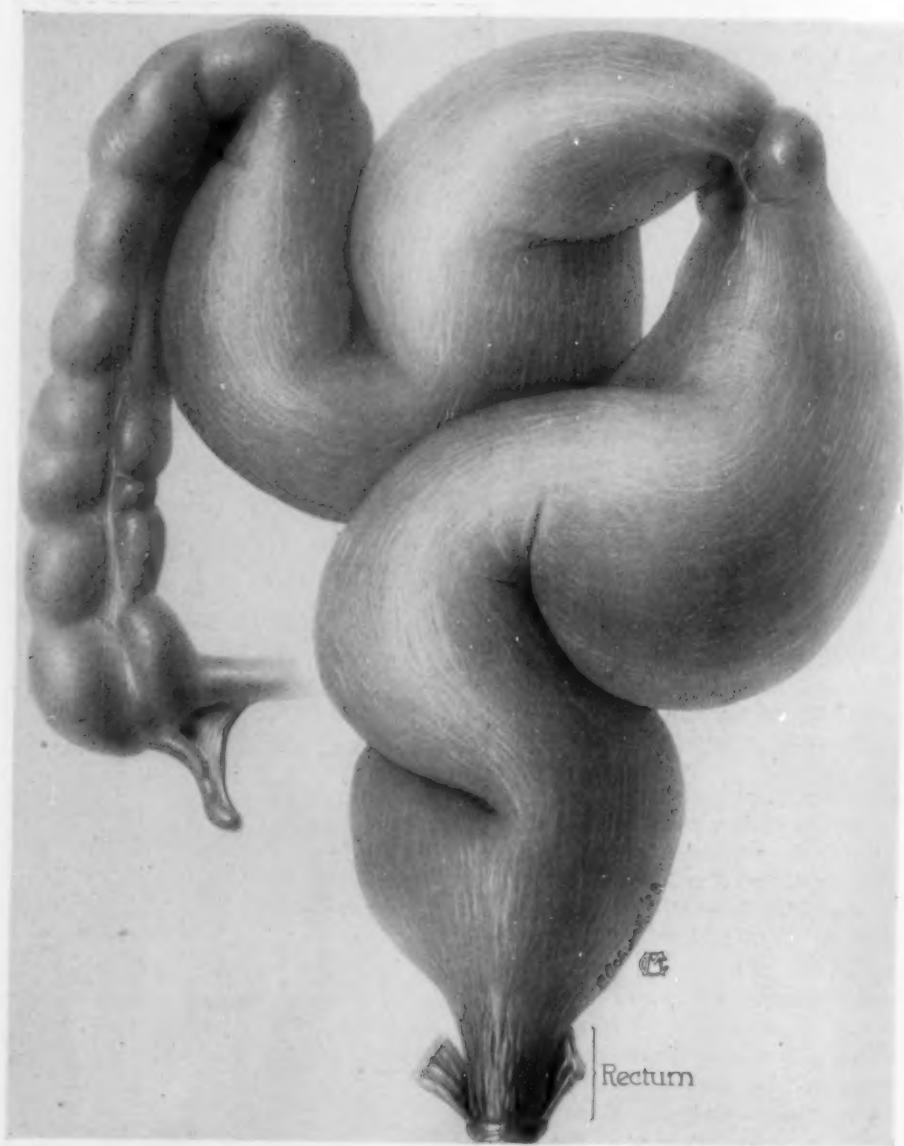
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FIG. 3.—Drawing of the colon made at the time of operation, illustrating the portions of the bowel involved and the absence of mechanical obstruction in the rectum. Patient shown in Figures 1 and 2.

through a transperitoneal Adson approach.† Unilateral sympathetic ganglionectomy was performed because the lesion was of moderate degree and left-sided.

Exploration of the abdomen revealed a more or less classical megacolon, which began from below, slightly above the juncture of the rectum and sigmoid, at about the upper level of the true pelvis and extended upward, involving the descending colon and about three-fourths of the distal portion of the transverse colon. The right hepatic flexure, the ascending colon, the cæcum and the rectum were normal in size and normal
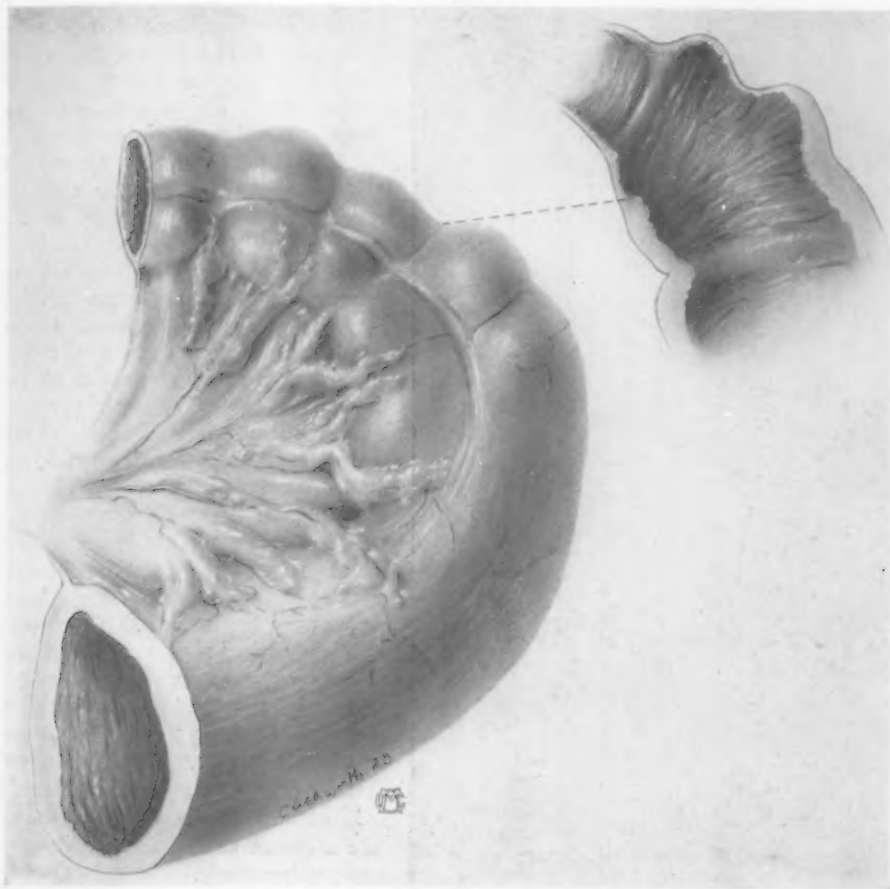
Fig. 4.—Drawing illustrating the absence of mechanical factors limiting the proximal dilatations of the transverse colon.

to palpation; the distended portion was several times larger than normal; the longitudinal bands were obliterated by irregular striations, as is so often seen over the entire surface of the involved bowel; on palpation, the wall was found to be moderately thickened, apparently a proportionate increase in all dilated and hypertrophied layers of the large bowel. On manipulation of this portion, a peristaltic wave would be initiated downward; the application of a hot sponge would produce a similar reaction and, in comparing the activity of the normal portion of bowel with that of the diseased portion, it was obvious that the diseased portion was more active than was the normal. The

† This operation was first performed March 19, 1925. It was discussed in a symposium on ramisectomy before the American College of Surgeons in the autumn of 1925, and published later in Surgical Clinics of North America, 1925, vol. v, pp. 777–789.

sigmoid and the descending colon were markedly adherent to the muscles in the iliac fossa and in the lumbar area, giving evidence of some previous inflammatory reaction.

The patient's post-operative course was uneventful. The temperature rose on the morning of the second day to 103.6°, returned to normal in the evening, rose to 100° on the third day, and again returned to normal in the evening. From that time until his

FIG. 5.—Patient shown in Figures 1 and 2 four months after bilateral lumbar sympathetic ganglionectomy and ramisectomy.

dismissal, on the twenty-first day after operation, the temperature remained normal. Fluids only were given for the first few days, semi-solids with fluids were given on the third and fourth days; he was then placed on a regular diet. The wound healed by primary intention.

On the third day after operation a mild enema was given, with a return of flatus and bowel material on the morning of the fourth day. The bowels had moved spontaneously before the enema was given. On the fifth day the bowels moved spontaneously immediately on insertion of the rectal catheter, previous to administration of the soapsuds enema. The catheter was withdrawn and, after expulsion of the formed stool, it was reinserted and a small enema was given, with further evacuation. Following this a small oil-retention enema was administered daily for the purpose of lubricating the mucous membrane and softening the feces, preparatory to discontinuing the soapsuds enemas. Later, small quantities of milk of magnesia were prescribed, this to be continued after the child's dismissal from the clinic. In a letter dated July 7, 1927, the mother said that the child was having normal stools independent of enemas and laxatives. The abdomen was distended and flatus was passing freely. He had gained in weight and seemed "wonderful" in every way. We advised the discontinuance of soapsuds enemas, the administration of milk of magnesia occasionally, the continuation of the oil enemas for a time then gradually decreasing them. In a letter dated August 8, the mother stated that the child's general condition had improved steadily, that he was passing from one to two normal stools daily, and that during the two weeks prior to her report it was necessary to administer only one soapsuds enema and two oil enemas. A letter dated April 10, 1928, reported that the child was doing nicely but was unable at that time to return for Röntgen-ray examination.

CASE II.—A child, aged six years, was admitted to the Section on Pediatrics, November 7, 1927. The chief complaint was enlargement of the abdomen and consti-

pation. The child had been a normal, full-term baby weighing eight pounds at birth. He was breast-fed for six months, had his first tooth at thirteen months, walked at eighteen months, and talked at fifteen months. He had been constipated from birth; for a week following delivery the bowels did not move. From that time until he was six months of age he was given daily potions of castoria, olive oil, and enemas. When he was six months of age, all measures had failed to bring about evacuation of the bowels for three days. The mother stated that the child had never had a normal bowel movement, that the abdomen had been markedly distended since he was six months of age, and that frequently he was taken to the hospital for special treatment of purgation, massage, enemas, and so forth, to empty the distended bowel. The usual routine was continued at home in the intervals, with only partially good results. There had always been much flatulence, and vomiting occurred whenever the abdomen was distended. Nocturnal enuresis had not been present; diurnal enuresis had occurred daily.

On admission, (Figs. 1 and 2) the child's height was 107.5 cm.; his weight 22.2 kg. (normal weight 18.6 kg.) ; the pulse was 90 and the temperature 98.8°. The chest measured 57.5 cm. in circumference, and the abdomen 68.7 cm., but the mother stated that it measured 87.5 cm. in circumference when the constipation was severe. The child appeared to be well developed, and fairly well nourished. The outstanding feature in the examination was the markedly distended abdomen. On palpation, the distended cæcum and transverse colon could be made out readily; peristaltic waves were also visible. Neither the spleen nor the liver could be palpated. The lower border of the wall of the chest had an outward flare. The tonsils were slightly enlarged and injected,

FIG. 6.—Anterior view of patient shown in Figure 5.

and there was some mucus in the pharynx. A discharge from the right eye was due to dacryocystitis. The specific gravity of the urine was 1.030; it was acid in reaction, contained a faint trace of albumin, but did not contain casts or cells. The hæmoglobin was 60 per cent., the erythrocytes numbered 3,740,000, and the leukocytes 7,600; the color index was 0.8. Röntgenograms of the rectum and sigmoid showed dilatation, graded 4, and some distention in the transverse colon.

Because of the persistent constipation and abdominal distention, medical treatment was carried out in an attempt to evacuate the sigmoid and colon thoroughly and, at the same time, to maintain a high calorie nonresidue type of diet in preparation for some form of surgical treatment. Various consultants in the clinic offered suggestions with reference to treatment for pre-operative preparation and surgical intervention. An enema was given from one to three times a day, together with occasional doses of castor oil and 5 minims of pituitrine every four hours, for two-day periods, and occasionally

hypodermic injection of atropine. The diet consisted of soups, bouillons, broths, and tomato juice. A little later, after the abdomen had become somewhat reduced in size, cream soups, gelatin, and butter were added. The diet was reinforced at all times with candy and sugar and, just previous to operation, scraped beef was included in the diet. Since the megacolon, in this case was more extensive than in Case I, bilateral lumbar sympathetic ganglionectomy and ramisectomy was advised and was performed on December 21, 1927 (Adson).

On opening the abdomen, (Figs. 3 and 4) the dilatation and hypertrophy was found to extend upward from the rectosigmoid juncture. It was most marked opposite the middle of the sigmoid, and then tapered off toward the splenic flexure. It involved the transverse colon, but not the hepatic flexure, ascending colon, cæcum or rectum. The wall of the sigmoid was three times as thick as normal and the hypertrophy appeared to involve the serosal, muscular, and mucosal coats, equally. About 20 cm. from the hepatic flexure, the hypertrophy disappeared without obvious explanation and the remaining portion of the colon was free from bands, adhesions, or any gross lesion. The initial involvement appeared to be in the sigmoid, spreading then to the descending colon, splenic flexure and to approximately two-thirds of the transverse colon. The hepatic flexure, ascending colon, cæcum, and small intestine were normal on palpation, and in appearance. The muscular contraction of the hypertrophied portion of the sigmoid, as well as that of the transverse colon, was very active; on the slightest manipulation of the bowel or application of a sponge soaked in hot physiologic sodium chloride solution, violent peristaltic waves developed. There was nothing particularly abnormal about the ganglia on either side, except possibly that the second lumbar sympathetic ganglion on the left side had more communicating rami than is usual and that there appeared to be two distinct rami extending into

Fig. 7.—Patient shown in Figure 5 four months after operation.

the mesentery of the sigmoid, which had been reflected. There appeared to be slight enlargement of the second lumbar sympathetic ganglion on the right side. The white ramus was easily distinguishable on both sides, so that when the operation was com-

pleted, all of the second, third, and fourth sympathetic lumbar ganglia, as well as the sympathetic trunks and all of the rami, were removed well above the second lumbar transvertebral foramen and below the fourth. The lumen of the sigmoid was from 7.5 to 10 cm. in diameter, and that of the transverse colon was from 5 to 7.5 cm. in diameter. The normal rectum is about 3.75 cm. in diameter, and the normal descending colon about 3.75 to 5 cm. in diameter.

The post-operative course was uneventful and unusually mild. On the first and second days the temperature rose to 101°, on the third and fourth days to 100°, and from then until the time of the patient's dismissal it remained perfectly normal. A small soapsuds enema was administered on the third and fifth days with return of col-ored fluid. By the sixth day, the child's diet had been reëstablished to what it was just prior to the operation, and following the enema much flatus and fecal matter were expelled. On each subsequent day, the results became more favorable, and a spontaneous bowel movement occurred on the eleventh day. Enemas were given daily, however, until the twentieth day, when normally formed stools were passed spontaneously and without difficulty. The abdominal wound healed by primary intention, and the patient was dismissed on the twenty-fourth day.

The patient returned for examination, April 20, 1926 (Figs. 5, 6 and 7). In contrast to the pasty-skinned, languid, cachectic-appearing child previous to operation, he was now vivacious, talkative, and very active, with a clear, pinkish skin, and reacting quickly to his environment. He was not constipated or

Fig. 8.—(Case II). The large bowel is shown greatly dilated. Peristaltic waves are not demonstrable during examination. Note absence of haustra (November 8, 1927).

toxic and was having one and two spontaneous bowel movements each day. He climbed on the examining table with ease, and was willing and eager to coöperate. He swung over a chair on his abdomen, as if nothing had ever been wrong. The abdomen measured 65 cm. in circumference, which is larger than that of the average child of six years, but there was less flabbiness of the skin over the abdomen and the tone of the abdominal muscles had improved. The lower margin of the ribs, instead of tapering in to close the thorax, flared outward, giving evidence of former pressure within the abdomen.

On percussion, tympanitic notes could be heard distinctly over the transverse and the descending colon. Peristaltic waves could not be observed to correspond to any portion of the large bowel. Numerous Röntgen-ray examinations were made (Moore) to determine the status of the sigmoid, descending colon, transverse colon, and ascending colon (Figs. 8, 9 and 10). A litre of barium enema, instead of remaining in the sigmoid, now filled the entire colon, as was noted in Wade and Royle's case. Active

peristaltic waves traveled along the large bowel and, in passing, compressed the barium to a mere pencil-line for a distance of from 10 to 15 cm. at a time. On examination under the fluoroscope after five hours, it was found that most of the barium had been expelled from the cæcum, and the ascending and transverse colon into the descending colon and sigmoid. Twenty-four hours after the original barium enema, fluoroscopic examination and plates showed that all of the barium had been expelled except for a small portion in the cæcum and sigmoid.

Surgical Procedure.—The incision is made from the symphysis to a point 7.5 cm. above the umbilicus, between the abdominal recti muscles and to one side of the umbilicus. The sheath of the rectus muscle is subsequently opened on each side below the umbilicus and, on the left side, above the umbilicus, facilitating closure along anatomic lines. If the abdomen is extremely flaccid, it may be advisable to make an overlapping closure (C. H. Mayo type) in the external leaves of the abdominal rectus fascia. Before the peritoneum is opened the patient is lowered from the horizontal position to a Trendelenburg position, thus insuring better exposure of the lumbar sympathetic ganglia. Although a general exploration may reveal other abdominal lesions, they are not disturbed at this time since we do not want to add

FIG. 9.—(Case II). Marked decrease in the size of the large bowel since operation. Rhythmical peristaltic waves were seen throughout the entire large bowel, producing deep contractions, and well marked haustra (April 20, 1928).

the additional risk of contamination. The intestines are packed upward, as is done in performing hysterectomy. It is immaterial whether one approaches the ganglia on the right or the left side first. Usually, the ganglia of the right side are more difficult to approach because of the intravertebral veins which run anteriorly and across the sympathetic trunk. It is more difficult to elevate the inferior vena cava than the abdominal aorta and the common iliac artery on the left.

In exposing the left lumbar sympathetic chain, it is necessary to loosen and elevate the sigmoid and the lower portion of the descending colon (Fig. 11). This is done by incising the peritoneum superior and just

lateral to the anterolateral border of the upper portion of the sigmoid and the attachment of the lower portion of the descending colon. When the line of cleavage is once started, the large bowel can be elevated readily and retracted with the posterior wall of the peritoneum beyond the median line, exposing the retroperitoneum, the ureter (as it crosses the bifurcation of the common iliac), the left common iliac artery and vein, the lower end of the abdominal aorta, the genitocrural nerve (which perforates the psoas muscle), the psoas muscle, the lumbar vertebræ, the lymph-nodes, and the lumbar sympathetic ganglia, trunk, and rami, which lie on the lumbar verte-

brae, just mesial to the psoas muscle. The ureter on the left side is more easily retracted mesially than laterally. It is held gently together with the colonic mesentery, the upper end of the sigmoid, and the lower end of the descending colon, in a median-line position with a sponge soaked in physiologic sodium chloride solution. The abdominal aorta is elevated and retracted mesially by finger traction on a gauze sponge. It is held by an assistant. The sympathetic ganglia, trunks, and rami are then dissected free by a wet cotton ball dissector held in thumb forceps. It is well to begin

FIG. 10.—(Case II). The large bowel practically empty twenty-four hours after examination. Catharsis was not given, but one soapsuds enema was administered just before the plate was taken.

at one or the other end of the lumbar sympathetic chain. On the left side, it is preferable to expose the fourth lumbar ganglion at the brim of the pelvis, and divide the sympathetic trunk below it. All of the rami, including those to the spinal nerves, the hypogastric plexuses, and the aortic plexuses, are then divided. The dissection is then carried upward to include the third and second lumbar sympathetic ganglia. Maintaining the sympathetic trunk and these three ganglia in continuity, the sympathetic trunk and the white ramus are divided above the second lumbar ganglion. The ganglia and the sympathetic trunk are removed in toto. The only disturbing feature which may be encountered is injury to a small intervertebral vessel or to the peritoneal vessels during the lateral dissection. All of these vessels are small, of no consequence.

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and may be ligated. If difficulty is encountered in the ligation of an intraver-
tebral vessel, a silver clip may be used. Undue traction should not be exerted
on any of the tissues handled, especially the mesentery leading to the sigmoid
and colon, so as to avoid the possibility of rupture or thrombosis of arteries
or branches of arteries supplying the large bowel.

The approach to the lumbar sympathetic ganglia on the right is similar
to that on the left, except that the peritoneal incision is made just lateral to
the right lateral border of the abdominal vena cava (Figs. 12 and 13), and is
carried downward over the right common iliac vein into the true pelvis,
upward and mesially along the root of the mesentery of the small intestine, partially across the vena cava for a distance of 15 cm. from the brim of the pelvis, and downward into the pelvis for a distance of 7.5 cm. The cæcum, the small intestine, and the ureter are retracted outward and upward. The vena cava is retracted mesially, and the common iliac vein downward and mesially. Several small veins just above the brim of the pelvis on the right side may be encountered in the posterior wall of the perito-

Fig. 11.—Mobilization of the sigmoid and descending colon to
expose the left lumbar sympathetic trunks, ganglia and rami.

neum, which can be divided and ligated. The further exposure and the
removal of the lumbar sympathetic ganglia and division of all of the rami
and the sympathetic trunk are similar to the procedures employed on the left
side. However, the fourth lumbar sympathetic ganglion on the right side
usually lies underneath the intravertebral vein and not superficial thereto, as
it does on the left side.

The closure consists in accurate apposition of both retroperitoneal inci-
sions to prevent retroperitoneal hernia, and accurate closure of the abdominal
wall to prevent post-operative hernia.

Post-operative Care.—These patients do not require any special post-
operative care. However, not knowing what to expect, we were extremely
cautious in the post-operative care in our two cases. Enemas of soapsuds,
physiologic sodium chloride solution and oil as well as laxative were pre-
scribed for the first patient for two months and then an oil enema occa-

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sionally. Enemas of soapsuds, physiologic sodium chloride solution and oil were prescribed for the second patient for three weeks, and an oil enema daily for two months, then intermittently for from four to five months.

Although the distention may recede somewhat slowly and the tone of the abdominal wall may be moderately slow in returning to normal, it is obvious, from the study of the two cases reported, that both are taking place; however, on account of the hypertrophy, the colon probably will never return to normal size.

Pathology.—The pathologic process is confined, usually, to the colon. In one-third of the cases, it involves the sigmoid flexure only. Terry reported a case in which ileosigmoidostomy had been performed, with subsequent development of mega-ileum, which would suggest strongly that a similar etiologic factor probably produced both the mega-colon and the mega-ileum. Fraser reported three cases of mega-ileum in children, as a result of a pathologic lesion at the ileocæcal sphincter. It is apparent that in the milder cases, the dilatation and

Fig. 12.—Mobilization of the cæcum and small intestine to expose the right sympathetic trunks, ganglia, and rami.

hypertrophy are confined to the sigmoid, but, as the rectal block becomes more pronounced, the process appears to extend proximally and to include the descending colon, the transverse colon, and the ascending colon. It rarely involves the cæcum or the lower end of the rectum. The transition from an abnormally dilated portion to a normal portion is usually gradual, but may be abrupt. Rarely is there any evidence of mechanical obstruction or of pronounced sphincters at either end of the dilatation in the so-called idiopathic type. In mechanical obstruction with resultant megacolon the block can be demonstrated distal to the dilatation. The dilatation and hypertrophy, apparently, are compensatory changes that develop in an attempt to remove the fecal content of the sigmoid. The dimensions of the dilated portion vary according to the degree of obstruction whether of neurogenic or mechanical origin and have been known to reach 15 to 20 cm. in diameter.[5, 9, 23] In Peacock's case the colon contained 16 litres of fecal material. The walls of the involved portion of the colon are apparently proportionately hypertrophied.
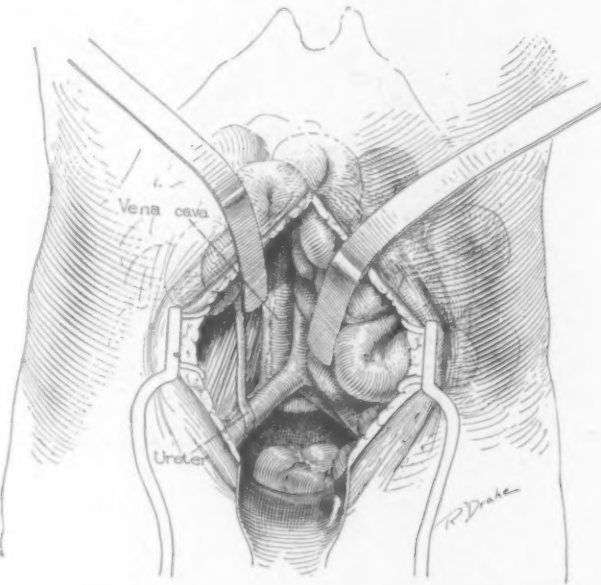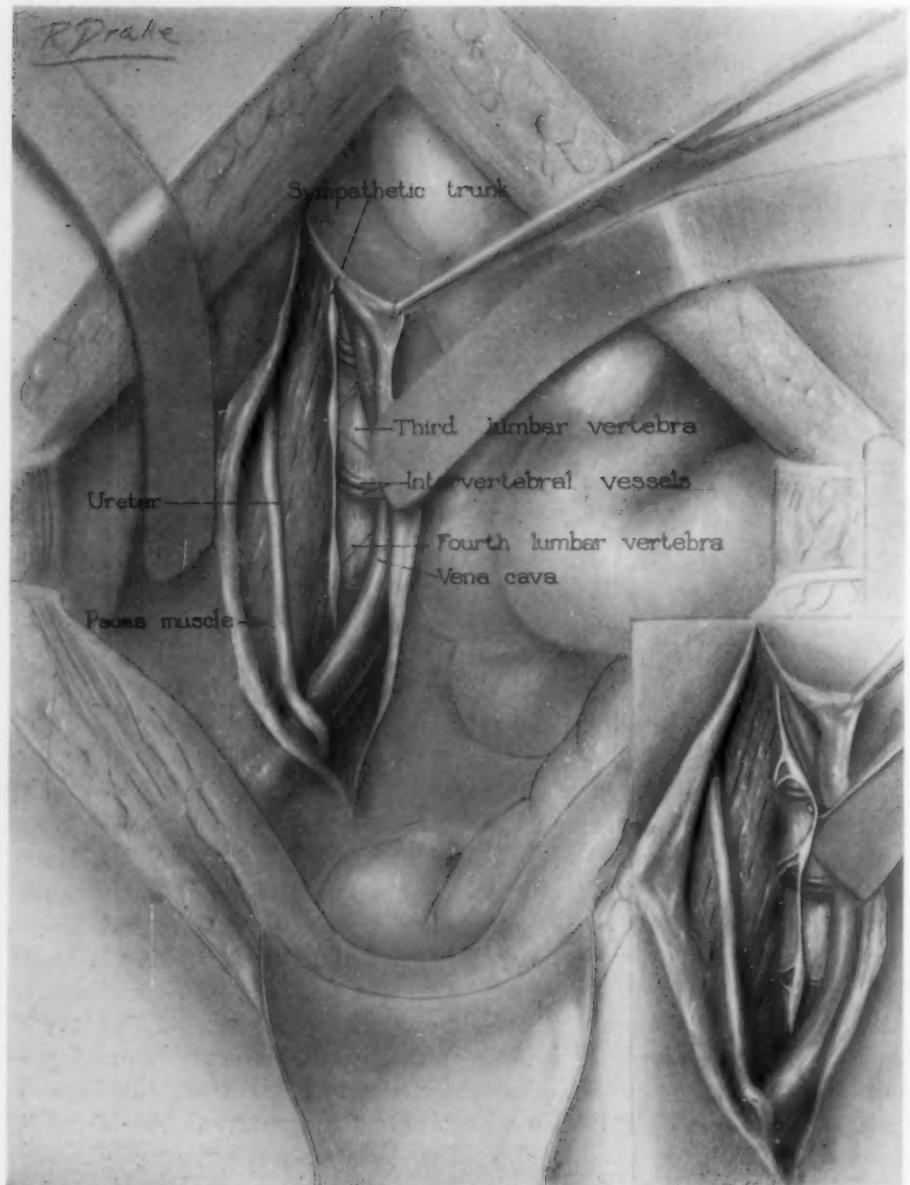
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FIG. 13.—Post-peritoneal incision exposing the second, third and fourth lumbar sympathetic ganglia, sympathetic trunk, and rami.

The serous coat is usually roughened, and the tænia less pronounced, or obliterated, thus giving evidence of peritonitis as the result of necrosis from pressure. The muscular coats and the submucosal and mucosal layers are also thickened. The lymph-vessels and blood-vessels are increased in size, usually, with an increase also in the size and number of the lymph-nodes. It is often observed that the mucosa is pigmented, and it may show patches of ulceration or scars from colitis, which have developed subsequent to chemical irritation and trauma from impacted feces. The Auerbach ganglia do not show any particular change; if anything, the cells are in clumps which are slightly larger than normal.

Symptoms.—The symptoms of megacolon are characteristic and striking. The two cardinal features are obstinate constipation and distention of the abdomen. In typical cases these symptoms appear during the first days or weeks of life and persist with brief periods of improvement throughout life. In some cases pronounced symptoms do not appear until later in childhood or adult life and in rare cases they are not manifest until late in life. The most striking feature is the extraordinary infrequency of the bowel movements in the absence of symptoms of acute obstruction. It is not uncommon for from three to four weeks to elapse without a bowel movement, and in a few cases three months are said to have elapsed between evacuations, as in the case reported by Gay. Ordinarily bowel movements are induced with great difficulty and large doses of drastic cathartics may be taken without producing any effect. The stools are often large, inspissated, and very malodorous. Unusual attitudes may be assumed during defecation, as leaning over a chair or the knee-chest position. At intervals there may be diarrhœa or vomiting. Ladd has called attention to the fact that daily liquid stools may pass and yet feces be retained. Abdominal distention may be present at birth to such degree as to interfere with delivery, as in cases reported by Hobbs and de Richmond. Ordinarily the distention appears within the first few days or weeks of life from the accumulation in the colon of feces and gas, and it varies indirectly with the activity of the bowels. It may be uniform and general or localized, corresponding to the position or content of the affected portion of the bowel. Correspondingly movable dulness and tympany may be elicited.

Secondary symptoms and signs which are often associated may include dyspnea, cardiac embarrassment, wide costal angle, thin abdominal wall, diastasis recti, distention of superficial abdominal vessels, displacements of thoracic viscera, hernias, audible borborygmus, œdema of the extremities, toxicosis and impaired nutrition.

Treatment.—In discussing the general treatment of megacolon we quote from Judd and Thompson:

"There seems to be no successful prophylaxis against megacolon although progress may be checked by early and judicious treatment. In addition to the fact that a practical cure may be obtained in a few cases by means of medical treatment, it is also of distinct value at certain stages of the disease

and also in the preparation of patients for operation. In very young infants or in undernourished subjects operative procedures are not well borne and dietary and hygienic measures must be relied on. As pointed out by Rankin, before any surgical procedures are applied directly to the colon, preliminary emptying of the bowel is of paramount importance.

"If patients are undernourished, the establishment of hygienic measures is desirable. The diet should be nutritious and easily tolerated. For these requirements, carbohydrates and foods with adequate vitamine content are desirable. In some cases, however, increased formation of gas is noted following diets rich in carbohydrate. Certain authors advise restriction of animal protein as prophylaxis against intestinal intoxication. Lactic acid milk is often of distinct value. On the other hand, a diet high in residue may be found to promote peristalsis. Before operation, however, a diet low in residue is required. Physical measures such as exercise, massage, the wearing of an abdominal support, electricity, enemas, the use of the rectal tube and rectal instillations of oil are all of value. The drugs which may be of use include mineral oil, laxatives, tonics, including arsenic and iron, dilute hydrochloric acid, cod-liver oil, and the physiologic drugs as atropine, pituitrine and thyroxin.

"The indications for surgical treatment are given by Terry as the presence of definite obstruction and the failure of medical treatment. According to Rankin, the selection of a surgical procedure is determined by the chronicity of the condition and the presence or absence of superimposed acute obstruction. In the presence of acute obstruction, drainage is indicated, and may be accomplished by ileostomy, cæcostomy or colostomy, removal of the obstruction being a secondary consideration. In cases of chronic obstruction removal of the obstruction by appropriate means is indicated. In a few of the so-called spasmodic cases or cases of partial obstruction, dilatation or division of the sphincters or a stricture, if present, has given apparent good results. In the idiopathic type of cases many procedures have been employed. Among the earlier palliative measures used were intestinal puncture, colotomy, colopexy, coloplasty and plication of the colon which did not afford definite results. Enterostomy, appendicostomy and colostomy are of distinct aid in emergency drainage, preliminary to resection, or for the purpose of through-and-through irrigation of the affected bowel. Of the more radical procedures, Mirizzi recommends total colectomy on the basis of recurrence in 25 per cent. of his cases. Exclusion of the colon by ileosigmoidostomy is strongly advocated by certain observers. But this procedure alone does not prevent reaccumulation of feces in the excluded loop. To overcome this objection Sistrunk recommends section of the sigmoid above the anastomosis and utilization of the proximal stump for colostomy with colectomy being performed later if desirable. Rankin recommends exteriorization by the Mikulicz method when possible, but otherwise prefers the intraperitoneal resection using the aseptic basting stitch method of Kerr."

Analysis of the Sixty-five Cases.—Judd and Thompson have reviewed

sixty-five cases of megacolon seen at the Mayo Clinic between January 1, 1908 and January 1, 1928. Of this number eight were the so-called pseudo-megacolon or secondary type and fifty-seven were idiopathic. Other congenital anomalies were associated in nine of the cases. However, five of the fifty-seven cases of megacolon had congenital deformity of the anal canal or lower portion of the rectum. While this deformity may have been a factor in the production of the condition, the megacolon persisted after the deformity was corrected. Forty-two of the fifty-seven typical cases of megacolon occurred in males, and fifteen in females.

Infrequency of bowel movements was stressed in thirteen of the fifty-seven cases. In twelve of these, the period between bowel movements ranged from five to seventy-two days. One patient, a girl aged twenty-one, stated that she had gone as long as nine months without defecating but that ordinarily movement of the bowels occurred every one to three months.

In twenty-seven of the fifty-seven cases of idiopathic megacolon medical treatment was given. In thirty surgical treatment was given. Sixteen of the twenty-seven patients who had been treated medically were traced. Thirteen of the sixteen had improved and three had subsequently died.

Several types of surgical procedure were employed in the thirty cases in which operation was performed. In seven cases appendicostomy or cæcostomy was performed to facilitate through-and-through irrigation of the colon. Of five of these patients whose follow-up records are complete, one is cured several years after closure of the appendicostomy opening, one improved after irrigations, one died from intoxication following operation and two died at periods of several months after operation from unknown causes. Short-circuiting procedures were employed in six cases; this included ileostomy in one case and ileosigmoidostomy with exclusion of the affected colon in five cases. The records were complete of five of these patients. Two were cured eight and thirteen years after operation; one was improved, and two had died from post-operative complications. In fourteen cases, radical resection of the affected colon was performed. Complete records were obtainable in thirteen. Eight patients were cured six to eighteen years post-operatively; one had not improved, and four died post-operatively. The Mikulicz operation was employed in eight cases, total colectomy in three, and anterior partial resection in three. In one of the earliest cases fecal impaction was broken up intraperitoneally and this procedure was followed by improvement. In our two cases lumbar sympathetic ganglionectomy and ramisectomy was performed with entirely satisfactory results.

To summarize the results of surgical treatment in the twenty-six cases in which the records were complete, thirteen (50 per cent. of the patients) were cured, three (11.5 per cent.) were improved and a like number were not improved. In other words, 61.5 per cent. of the twenty-six patients were cured or improved, and 38.5 per cent. had died or were unimproved. From this analysis it would appear that while surgery of the colon offers some pros-

pect of a cure of megacolon, nevertheless, it is attended by a great hazard and any treatment that offers a chance of relieving the condition with less risk is certainly justified.

SUMMARY

In view of the diversity of opinions concerning the etiologic factors and treatment of megacolon, we have been stimulated to follow the suggestion in Wade and Royle's original article, and by a personal report from Wade to Alvarez of our staff. Wade reported four additional cases of megacolon, in which he had operated. In two of these the results were as satisfactory as the one reported by Wade and Royle. In the other two the results were unsatisfactory. Wade commented on the operation and stated that these were extremely difficult cases to treat and that there was some uncertainty about the completeness of the operation.

In searching for an explanation of the results obtained in the two cases reported here it is found that many men have attributed congenital idiopathic megacolon to a neuropathic cause suggesting a disturbance in the coördinating mechanism of the rectosigmoid sphincter, or a disturbance in the anal sphincter. According to Fraser and Hurst, failure to relax is the chief factor. According to Royle and Hunter, a postural tone has been superimposed on the rectal mechanism which has disturbed the coördinating mechanism. The latter view had previously been suggested by Gaskell and Sherrington.

Cunningham, in his text-book on anatomy, stated: "The pelvic part of the sympathetic trunk, like the cervical and lower abdominal portions of this system, receives no white rami communicantes from the spinal nerves. The visceral branches (pelvic splanchnic) of the third sacral nerve, and usually, also, the second or fourth sacral nerve, enter the pelvic plexus without being directly connected with the sympathetic trunk. These nerves, however, are to be regarded as homologous with the white rami communicantes of the thoracicolumbar nerves (abdominal splanchnic). They convey to the pelvic viscera (1) motor and inhibitory fibres for rectum, uterus, and bladder, (2) vasodilator fibres for the genital organs, and (3) secretory fibres for the prostate gland.

"This portion of the sympathetic trunk is placed on the pelvic surface of the sacrum, medial to the anterior sacral foramina. It is connected above by a cord with the abdominal portion of the sympathetic, and below it ends in a plexiform union over the coccyx with the trunk of the other side, the two being frequently connected by the ganglion impar or coccygeal ganglion. The number of ganglia is variable; there are commonly four. They are of small size, gradually diminishing from above downward.

"Central communicating branches arise irregularly in the form of gray rami communicantes from the sacral ganglia, which join the anterior rami of the sacral and coccygeal nerves.

"*Peripheral Branches of Distribution.*—1. Visceral branches of small size

arise from the upper part of the pelvic sympathetic trunk, and join the pelvic plexus. 2. Parietal branches, also of small size, ramify over the front of the sacrum, and form, in relation to the middle sacral artery, a plexiform union with branches from the sympathetic trunk of the other side.

"The nerves of the rectum come partly from the sympathetic and partly from the cerebrospinal system. The sympathetic fibres are derived from the inferior mesenteric plexus, through the superior hemorrhoidal nerve and the corresponding plexus, and from the upper and lower divisions of the hypogastric plexus, the former accompanying the superior hemorrhoidal, the latter the middle hemorrhoidal vessels, to the rectum. The cerebrospinal fibres arise from the second, third, and fourth sacral nerves soon after these leave the sacral foramina (and constitute the 'pelvic splanchnics' of Gaskell). They run forward in the pelvic connective tissue, and joining the pelvic plexuses, reach the side of the rectum. Fibres of the inferior hemorrhoidal branches of the pudendal nerve (third and fourth sacral) are also distributed to the lower part of the anal canal as well as to the external sphincter.

"It has been shown by experiments on animals, that the cerebrospinal nerves (from the second, third, and fourth sacral) convey motor impulses to the longitudinal fibres, but inhibitory impulses to the circular muscular fibres. In like manner the branches from the sympathetic convey motor fibres (derived from some of the lumbar rami communicantes) to the circular muscle, and inhibitory fibres to the longitudinal muscle of the rectum.

"The reflex centre which governs the action of the sphincters and the muscular fibres of the rectum ('defecation centre') is situated in the lumbar region of the spinal medulla, and appears to be capable of carrying out the whole act of defecation even when separated from the brain."

In reviewing nerve supply of the rectum, calling to mind that gross pathologic change is not found in the rectum in cases of idiopathic megacolon and, since both of our patients were relieved by lumbar sympathetic ganglionectomy and ramisectomy, we believe that relief obtained by reëstablishment of coördinating mechanism is due to reduction of the sympathetic stimuli coming from lumbar rami communicantes through the hypogastric and pelvic plexuses.

The result is not necessarily due to division of the white ramus or to removal of the lumbar ganglia. It is probably due to a thorough interruption of the sympathetic chain below the last white ramus, preganglionic fibre to the lumbar ganglia. The division of the lumbar sympathetic chain diminishes the sympathetic stimuli to the circular muscles of the rectum. Because of these facts, we believe that so-called idiopathic, congenital or acquired megacolon is the result of hyperactivity of the sympathetic innervation of the rectum, and that when symptoms of obstruction and toxicosis develop, division of the lumbar sympathetic trunks should be considered.

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EFFECT OF SYMPATHECTOMY UPON THE PAIN OF ORGANIC DISEASE OF ARTERIES OF THE LOWER LIMBS AND FOR OBSCURE ABDOMINAL PAIN

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I propose to discuss first the question of pain and the probable paths of pain impulses, in the lower limb, as found in cases of organic disease of arteries, *viz.*, arteriosclerosis leading to senile gangrene, and thrombo-angiitis obliterans leading to pre-senile gangrene, with particular reference to the operations directed against the sympathetic nerve paths; secondly, to consider the possibility of relieving obscure abdominal pain, untouched by previous abdominal operations of the ordinary kind, by a ramisectomy in the lower dorsal region, as carried out by von Gaza in 1923. I leave aside entirely the efferent or motor side of the sympathetic system; and also the sensory side in its applications to supra-diaphragmatic pain, in particular the forms of angina pectoris.

It may be well to begin with a very brief summary of the anatomy of the sympathetic system, and its connections with the cerebro-spinal system.

The ganglionated cord, as a sort of centre, receives sensory sympathetic fibres direct from the visceral and the vascular plexuses at the periphery. In the case of the vascular plexus, it receives them (a) directly from the main trunks, the femoral and iliac arteries, and (b) indirectly, from the spinal nerves, sciatic, crural, etc., the original sympathetic fibres leaving the arterial walls at various levels to join the spinal nerves, and ultimately leaving the spinal nerves, presumably in the gray rami communicantes, to join it in its lower or lumbar ganglia. On the motor side, it sends out through the gray rami vasoconstrictor, or viscero-motor fibres into the spinal nerves adjacent, and also, pretty certainly, directly along the main arteries and to the visceral walls. The visceral sensory and motor fibres probably travel also along vessels, at least in that portion which adjoins the gut. Now, as regards the further course of sensory fibres from the ganglionated cord into the spinal cord, it has been fairly well demonstrated that the majority of these run in the white rami and through the anterior or dorsal roots (Lehmann, Foerster), although probably some still travel through the posterior roots, either relaying or not in the posterior root ganglia.

Their further course in the cord on the road to the higher perceptive centres, chiefly the optic thalamus, is very imperfectly known; but at any rate the path is probably not in the antero-lateral columns, which convey the impulses of pain, heat, and cold, coming up by the cerebro-spinal nerves. These last, by the way, do not all cross, but run up on both sides of the cord. The path of the sympathetic fibres in the extremities is believed to be con-

fined to the two routes mentioned. Sensory nerve endings have been demonstrated by Woollard on the arterial walls. From this point of origin the fibres mostly, after a length of course which is unknown, leave the arteries and join the neighboring spinal nerve; but it is fairly certain that others stick to the artery, and run their whole course along it, right up to some point in the lumbar region where they leave to go direct into the lumbar ganglionated cord. This last assertion, one should add, has been stoutly denied by some, in particular Wiedhopf and Dennig, but in my judgment, the evidence for it afforded by Friedrich and by Abrashonow is too strong to admit doubt. The sympathetic sensory supply to the limbs is undoubtedly dual. Let us now pass to the clinical side.

The earlier operations of Leriche, whose name is rightly associated with the procedure of periarterial, or, as he himself suggests, more correctly, arterial, sympathectomy (inasmuch as it differs essentially from Jaboulay's operation) were designed to influence the nutrition of the limb by means of the marked and lasting hyperæmia, which followed a preliminary spasm of the artery; and this especially for the cure of intractable ulcers. But the accessory observation was soon made that in many cases the pain, which so frequently accompanies conditions of imperfect circulation in the feet and legs, was immediately or very shortly relieved. Leriche considered, and still, I believe, considers, that the relief of pain was due to restoration of sufficient circulation. Consequently, the operation of periarterial sympathectomy was quickly and widely adopted for the type of case which we are discussing, namely, the loss of good circulation in the feet in cases of arteriosclerosis and of Buerger's disease, in the hope of killing two birds with one stone, improving the circulation and relieving the pain.

At this point may I be allowed a short digression to discuss the exact cause of the pain in these conditions. Arteries are sensitive. We know it clinically and experimentally. They are sensitive to direct trauma, to inflammation, and it can hardly be doubted that they are sensitive to changes in their own blood supply, that is a lessening of blood supply to their own walls as to neighboring tissues. The essence thereof probably lies in a disturbance of the acid-base equilibrium through imperfect oxidation of the cells constituting the nerve endings (Payr). Clinically, anyone who follows carefully those cases of Buerger's disease and of arteriosclerosis which show in the foot the signs of imperfect circulation must be struck by the parallelism between these signs and the degree of pain. While the circulation is returning in frozen members, and as long as it is imperfect, pain is severe. In a patient of Brüning's in whom a periarterial sympathectomy in the pregangrenous stage had relieved pain, this recurred as the circulation failed further, and was relieved by an injection of the sciatic nerve. And in my own cases the sequence of events has confirmed me in this view.

Nevertheless, this is not all. Circulation may not be improved, and yet pain may be stopped by a sympathectomy, as is shown in the following instance.

CASE I.—T. M., aged seventy-four, admitted to the Royal Victoria Hospital on July 9, 1924. This patient's leg had been amputated at the knee by Dr. F. A. C. Scrimger on July 17, for arteriosclerotic gangrene of the left foot. The popliteal vessels were thrombosed. Very soon after the amputation he began to complain of two distinct pains; one was the ordinary pins-and-needles sensation referred to the foot of the amputated leg. This was very little troublesome. The second pain, a new pain, was described as being of intense, burning character, situated in the stump, which came on in violent spasms very frequently, both day and night, to such an extent that before long it was necessary to have recourse to morphia in considerable doses. During Doctor Scrimger's absence this man came under my care. I convinced myself that his pain was genuine and of the greatest severity. It was not relieved by any of the ordinary drugs and even morphia procured only a very relative relief. I could discover no amputation neuroma, although two or three points in the stump were tender on pressure. On August 21 I removed the sheath of the femoral artery in Scarpa's triangle. The vessel was found to be markedly atheromatous and was thrombosed, as no pulsation was present. In this case, therefore, the removal of the sympathetic plexus in the sheath could have no effect on the circulation, at any rate at this point, nor at the popliteal, and any good effect that might result could not be ascribed to an alteration in the circulation but only to an interruption of pain-carrying fibres. Following the operation his pain was relieved and remained relieved during the six months of his stay in hospital. An unhealed area in the stump did not seem to be particularly affected by the operation and the leg did not show the evidence of any improvement in circulation.

In this case one had to conclude that as a result of the amputation some process had been set up whereby the sympathetic nerve ends, presumably in the ligated artery at the knee, were irritated, giving rise to painful spasms. This observation, I may mention in parenthesis, constitutes a point against the theory of Dean Lewis that improvement as regards pain may be set down to improvement of the collateral circulation through the profunda as the result of the operation which he has proposed recently, namely ligation of the femoral artery, in the idea of forcing a more rapid development of the collateral circulation.

So that I conclude that the adventitia does carry nerve fibres along the femoral artery, the interruption of which can at times stop pain.

But the general experience of periarterial sympathectomy in these two types of cases is one of failure to relieve pain more often than of success. To what are we to attribute the failures? In the present state of our knowledge, we cannot go far in the answering of this question. But I may be allowed to point out certain probable explanations.

First—Although we naturally assume that it is the sympathetic fibres that are alone involved, we have not yet proved that the pain may not in some cases originate in and travel by the spinal nerve fibres to the exclusion of the sympathetic.

Second—Admitting that the pain travels by the sympathetic, there are still two paths which may be taken, and the pain impulse may choose the spinal nerve path and ignore the long path along the arterial wall. The connecting twigs between the artery and the spinal nerves are segmentally arranged and are markedly irregular in the sites of juncture, as shown by Kramer and Todd for the arm and by Potts for the leg. So that a periarterial sympathec-

tomy may strike in at a point which does not happen to catch the particular sympathetic fibres concerned. The fibres may go off to the spinal nerve below, or come in to the artery above the usual site of a sympathectomy in the lower part of Scarpa's triangle. The variations are sufficient to explain many failures.

Finally, the persistence of pain is sometimes due apparently to the advance of gangrene, involving new territories and irritating a fresh group of sympathetic nerve endings. This may occur immediately, or only after a period of temporary relief from pain.

Or again the pain in one spot, as in the toe, may persist, while pain in the metatarsal region, or the heel, or the calf, coincidently present, may disappear. Such a sequence suggests strongly the existence of more than one sensory path, indeed of many paths, and agrees with the conception of an irregular segmental distribution. The task of working out these paths will be a difficult one; but it can perhaps be solved by a much more thorough clinical investigation and history, along the lines laid down by Sir James Mackenzie, than has been the custom in the past; perhaps also experimentally with the help of Adrian's method of recording pain sensations in animals. However this may be (we come back to the practical problem) in view of the fact that in well over half the cases a periarterial sympathectomy fails to relieve pain. We must ask ourselves whether or not, it is worth while to do that operation at all? In cases in which gangrene is not present but only threatening, it is obviously worth while, because in some the circulation may still be improved, pain relieved, and gangrene staved off (as in three of my series of ten). But when gangrene is already present, why do it? If gangrene persists the patient must come to amputation, and that usually relieves pain with certainty. Why not, therefore, amputate and be done with it? The answer, I take it, is that nobody wants his leg amputated as long as he can avoid it. If the gangrene is limited to part of one or more toes, and is dry, the patient is far more concerned over his pain than over his black toe. Relieve him of his pain, and he will disregard the toe, and may even go about his business and allow nature to amputate the toe when it will. As a matter of fact, the element of pain dominates the situation much more than does the gangrene, which is so often over long periods of time quite limited in extent. Moreover, time that is free of suffering is time gained,—a precious interval during which collateral circulation may gradually develop, and either render amputation unnecessary, or allow amputation at a low level. Many amputations in Buerger's disease have been done at the knee, because of the patient's refusal to endure any longer his agony. My attitude therefore is that any minor surgical procedure, such as periarterial sympathectomy, which can offer a reasonable chance of relieving pain, deserves a trial in all cases of limited and stationary gangrene. But when this operation fails to relieve pain, what is one then to do? In the past, amputation at the knee has been very frequently done, since it nearly always cures both pain and gangrene. And in the case of arteriosclerotic gangrene in elderly patients, where the onset of

gangrene is so often due to a final blocking of the popliteal artery, and it is consequently a hopeless task to try and save the lower leg, I believe that is ordinarily the best policy. But with Buerger's disease, the problem is different. The patient is younger and needs his leg and foot "for his business"; the site of the circulatory block and its modus operandi are different, allowing a much greater chance for the slow development of collateral circulation; so that, if pain can be relieved, the patient may be tided over the critical period and ultimately lose no more than a toe or two. The chances for a Leriche phenomenon with its hyperæmia, at least in the earlier stages before actual gangrene has occurred or when it is but of slight degree, are better than in arteriosclerotic gangrene. So that the operation, in my judgment, is here entirely recommendable.

But if it fails, it is obvious what one may or must do. One must attack the other route of sympathetic fibres in the spinal nerves. Inasmuch as the pain arises in the district of the terminal distribution of the sciatic, we can do something to the sciatic. To cut it is to paralyze the leg permanently, and therefore not advisable. But a temporary paralysis, which means usually not much more than a foot-drop, may be accepted. Lewis and Gatewood cured 5 cases of causalgia by injecting 60 per cent. alcohol into the sciatic. I have one patient who has been relieved in this way; and his report is interesting.

CASE II.—His age was thirty. For five months he had suffered severe pain in the left big toe, in the metatarsal region, and in the calf. There was a small indolent infected ulcer at the base of the nail, and the usual dull red discoloration at the base of the toe. No pulsation could be felt in the arteries of the foot, nor in the femoral. On January 16, 1928, a periarterial sympathectomy was done by Doctor Miller of my service. The femoral was found solid. One inch was excised, and the sheath removed over a length of 2 inches. The lumen was filled with a half organized clot. His pain was not modified. Inasmuch as Bazy has reported pain relief following a second sympathectomy extending up beyond the profunda, in three patients who were not relieved by a first sympathectomy done in the usual situation low in Scarpa's triangle, I reopened the wound on February 23, and removed the adventitia above the former site, clearing the femoral up to Poupart's ligament and also the profunda for half an inch. The femoral was blocked and I excised 1½ inches of it below the profunda; the latter artery was patent. There followed permanent relief from the pain in the calf, but none from that in the toe. On February 27, Doctor Miller injected the sciatic with 5 c.c. novocain, without exposing the nerve. There followed relief from all pain for four hours. On March 10, the sciatic was exposed, and injected with 6 c.c. of 15 per cent. alcohol. Pain was relieved only in part, and only for some eight hours. On March 22 the big toe was amputated, without relief. Finally, on April 16, the sciatic was again exposed, and injected with 10 c.c. of 60 per cent. alcohol. The result was that all pain disappeared for twenty-four hours. Then it recurred in the dorsum of the foot, but not in the toe. Yet it was relatively slight in degree. Morphia became unnecessary, and he was able to sleep, recovered cheerfulness; the result indeed was very much worth while. There was foot-drop, and a patchy anæsthesia in the thigh and leg. The wound at the base of the toe remained unhealed.

Of ten patients treated in the Royal Victoria Hospital in the last four years (of whom seven in my service, two in Doctor Keenan's, and one in Sir Henry Gray's) by periarterial sympathectomy, here considered in respect

of the relief of pain, seven were of the Buerger type, and three of the arterio-sclerotic type. Of the seven, two were cured of the pain and also of ulcera-tion and slight gangrene of the big toe, the cures dating from two and half years to six months ago. One was improved greatly; he had no ulceration. Four were failures. Of these three came shortly to amputation at the knee for advancing gangrene, pain not having been relieved, or as in one case, relieved only for a few days. The fourth was the one whose history is related above, whose pain was finally relieved by alcohol injection of the sciatic. The ultimate result in this last is yet to be seen.

In three of the seven the Leriche phenomenon of constriction was seen, but it was not followed by dilatation of the peripheral vessels; yet one of these went on to cure of the ulcer and relief of pain. The other two came to amputation. All cases amputated have been relieved of pain. Of the three arteriosclerotic cases, of which one was also diabetic, the history of the first has already been related. Violent pain arising in the stump after amputation at the knee, was cured by a femoral sympathectomy. In the second, the diabetic case, a popliteal sympathectomy was tried. Part of the big toe was gangrenous. Pain was not relieved, and after a week, amputation at the knee was done. In the third case, there was only threatening gangrene of the big toe, but the pain was excruciating. It was nearly always initiated by a coarse jerky trembling of the leg below the knee. The femoral, popliteal, and the two foot arteries could all be felt pulsating. A sympathectomy was first done on the posterior tibial and the dorsalis pedis, both of which were found atheromatous. There resulted no relief from pain, nor any improve-ment in the circulation. Five days later, the femoral adventitia was removed. The artery looked normal. No Leriche phenomenon was observed at either operation. For two days he was somewhat relieved; the vise-like quality of the pain was much less. But after four days he was suffering as much as ever. He insisted on going out, and would not accept an injection of the sciatic.

In three of the cases, the anterior crural nerve was injected with novocaine at the time of the sympathectomy, but without relief. The sciatic nerve would appear to be the only one concerned in pain arising in the foot.

It remains to mention the possibility of attacking the sympathetic higher up than the femoral artery. Upon a priori grounds, if the pain is of sympa-thetic origin, and if all sympathetic fibres, whether in the limb they travel along the arterial wall or in the spinal nerves, still meet at a common junction in the lumbar ganglionated cord, an attack upon this common meeting place ought to catch all sympathetic pain impulses from the lower extremity, and might be expected to relieve pain regularly. And as a matter of fact Brown reports from Adson's service in the Mayo Clinic five cases of thrombo-angiitis obliterans operated on by a bilateral lumbar sympathetic ganglionectomy with perivascular neurectomy of the common iliac arteries. In all there were "trophic ulcers" and pain was excessive. "Relief from pain was complete in all the patients and has persisted to date," (periods of three to seven

months). Brown and Adson, however, do not recommend the operation for cases of senile arteriosclerosis, on account of the increased risk in these usually feeble patients.

Such uniformly favorable results have been obtained by no other procedure. Although the series is small, it is significant. It speaks strongly in favor of the theory that the pain of circulatory anemia originates in sympathetic end receptors, and that it travels along sympathetic paths. Yet it may well be asked whether so extensive a removal of the lumbar sympathetic is necessary. I imagine that our efforts henceforth should be directed toward the rami communicantes, on either side of the sympathetic ganglia, where also the sympathetic supply is crowded into a narrow path. In the meantime, I conceive that the order of operation should be, first a femoral sympathectomy; or possibly, as our knowledge increases, a sympathectomy over a site on the main artery chosen according to the situation and character of the pain. Next, if that fails, an injection of the sciatic nerve with 60 per cent. alcohol or 5 per cent. formalin (which Foerster recommends), accepting the temporary foot-drop; and finally, if necessary, a last attempt of the nature of Adson's operation, or possibly a simple lumbar ramisection. All these procedures are directed solely towards the relief of pain during the stage at which the malady is uncomplicated by gangrene or the gangrene is very limited, dry and non-progressive. It is recognized that an amputation at the knee will practically always relieve pain, and represents a last resort after these smaller operations have failed.

I pass now to a consideration of the relief of chronic abdominal pain through cutting of the rami communicantes which connect the ganglionated cord with the spinal nerves and also with the spinal cord itself. Whatever one may think of the sympathetic supply to striated muscle and the sympathetic control of postural tone, and of the Hunter-Royle operation, one can have no doubt of the existence of sensory visceral fibres, and of their reaching the spinal cord through the rami communicantes.

According to André Thomas, the white rami contain pre-ganglionic fibres coming from the sympathetic column and ending in the spinal ganglia or in the cord, as well as also other elements of sensory nature and of various origins. The gray rami are composed of post-ganglionic fibres which originate in the ganglia and end in the periphery, after running in the spinal nerves and along the vessels. The outstanding example of a surgical attack designed to relieve pain through interference with pain paths running from the sympathetic ganglia to a peripheral distribution in visceral organs, is found in the operations on the cervical sympathetic ganglia, for the relief of the pain of angina pectoris. With this part of the subject I have nothing to do at the present time, but I would like to call your attention to another application of the same principle, concerned this time with the relief of chronic abdominal pain.

Von Gaza, in 1923, published an article which has been too little recognized. Von Gaza was greatly interested in that class of patient with whom

we are all only too familiar, in whom chronic abdominal pain brings the patient to the operating table time after time for various abdominal operations, each one of which in turn fails to afford relief. He was convinced that many of these patients show the stigmata of a general psychic and vasomotor irritability. For instance one sees in them dermographia or wheal formation upon slight skin irritation. This is clearly an effect of irritability in the musculature of the superficial blood-vessels. He argues that the same condition may be present in the involuntary muscle of the abdominal organs, or perhaps in the vessels supplying those organs. Thus, in the stomach, such patients are apt to suffer from hypersecretion and hypermotility, and sometimes from erosions of the mucosa and petechial hæmorrhages. In the bowel it is called mucous colitis. They are often the victims of repeated futile abdominal operations at which no explanation of the pain can be found in organic changes. In succession the appendix is removed, or an ovary resected; then the gall-bladder excised, and finally, perhaps, a colopexy is done in order to support a supposedly mobile cæcum. Usually the pain recurs after each operation, except in a few instances, in which, as von Gaza believes, the sympathetic fibres supplying these organs may well have been stripped and torn, thus incidentally interrupting the sensory path through this system of nerves. The condition he considers as one of intra-abdominal vasomotor and enteromotor neurosis, in which segments of the vegetative nervous system, and especially the segments to which the afferent and efferent paths running in the rami communicantes belong, are in a condition of neurotic dysfunction. The condition he thinks is one of "irritative weakness" of the vegetative nervous system, and often due to psychic trauma; and he found it apt to occur in people of asthenic type or in the adipose. Whether the pain was due to neurotic cramp of vessels or of muscles, he thought it impossible to determine.

Upon the basis of this theory it seemed obvious that one might be justified in an attempt to interrupt directly the path of such pain impulses by cutting the rami communicantes through which the afferent or sensory nerves of the sympathetic had to run in order to reach the cord and thence reach the ultimate pain perceiving station in the brain.

It was, however, clearly important to make an exact topical diagnosis of the pain and of the rami through which such pain impulses passed; and von Gaza in this respect acted upon the knowledge afforded by Kappis and Läwen. Kappis, by means of section of the cord at various levels, and Läwen, by means of paravertebral anæsthesia with novocaine, had been able to fix approximately the levels of the segmental sympathetic innervation of the viscera. The practical method was that of Läwen, which consisted in an injection of 10 c.cm. of 2 per cent. novocaine into the intercostal nerves, just outside the lateral vertebral foramina, at various levels, the novocaine diffusing through into the rami and posterior root ganglia; so that the pain of a gall-bladder inflammation, or of a kidney lesion, or of a stomach lesion, according to the segmental level, might be relieved in this way for a few

hours. Von Gaza's procedure, therefore, in some fifteen cases of the type described, was to inject paravertebrally at appropriate intervals of time the intercostal nerves from the eighth dorsal down to the twelfth, and see at which level the abdominal pain was abolished. At times one or two injections would apparently relieve the patient for prolonged periods; in one case permanently. Having thus made a topical diagnosis of the segmental level of the pain, he proceeded in one case to cut the rami communicantes at the level of the tenth dorsal, removing at the same time the posterior root ganglion. This was followed by a permanent cure.

Von Gaza does not seem to have found imitators, for I can find no record of similar operations having been performed in the intervening period; yet I feel that there is something very promising in this procedure, if one can select the cases aright. Doctor Scrimger, assistant surgeon to the Royal Victoria Hospital in Montreal, and adjunct surgeon in my service, called my attention to von Gaza's article, and was the first, so far as I know, to repeat von Gaza's operation. This was in the fall of 1926. Since then we have each operated on another case, three in all. He will shortly publish a detailed report; but meanwhile, with his permission, I may give you a short account. Technically, the operation is not difficult. Through a laminectomy incision, one shoves back the muscles on the side affected, chisels through the transverse processes, and removes these by blunt and sharp dissection; whereupon the intercostal nerve is easily exposed, after cutting through the intercostal muscles, at its entrance in the intercostal space. The nerve is hooked up, and there then appear, dragged up with the nerve, the rami concerned, usually two in number; fine twigs, but discernible without difficulty. These are cut across or evulsed at their junction with the spinal nerve. The wound is then closed as usual. One danger is that of tearing or cutting the pleura. In the patient that I operated on, this accident occurred through my thoughtlessly using a sharp knife for dissecting out the transverse process. I plugged the opening with a muscle graft, but some pneumothorax persisted and some effusion appeared in the pleural cavity. This seemed in the next ten days of no consequence; but on the tenth day as she was straining at stool, sitting up in bed, she became suddenly dyspnœic, intensely cyanotic, and died in fifteen minutes. The pathologist diagnosed bilateral pneumothorax and death from asphyxiation, as the lungs were collapsed and showed, with other organs, the usual signs of asphyxiation. I can myself give no other explanation, although no hole could be found in the mediastinum to explain the sudden irruption of air from one pleural cavity into the other. I am glad to say that Doctor Scrimger's two cases came through perfectly.

I may now report these three histories very briefly. The first, Miss F., aged twenty-eight, operated on in the summer of 1926, by Doctor Scrimger, had suffered for several years from chronic left-sided abdominal pain, localized chiefly in the distribution of the eleventh and twelfth dorsal segments. She had had several operations; the left ovary had been removed for a cyst; the appendix also. An exploratory operation, ending as such, had been done. Finally, she was suspected of a left pyelitis, though examination did not confirm this sufficiently, so that she escaped a nephropexy or a nephrectomy.

None of these measures relieved her pain. She was generally regarded as a trying neurasthenic. Finally she came under the care of Doctor Scrimger in my service, who after establishing her segmental level of pain by Läwen's method, cut the rami of the eleventh and twelfth dorsal nerves; since when she has been entirely relieved, and extraordinarily grateful.

The second case was the unfortunate one operated on by myself. She had begun to suffer from right-sided abdominal pain in the lower quadrant in 1923, accompanied by constipation and nausea, and by frequency of urination. In April, 1925, she had been operated on under the diagnosis of chronic appendicitis. The appendix was removed and an extensive colopexy done. The pain was unrelieved. At this operation, all the organs were found normal, except for appendiceal adhesions and a parieto-colic band. In December, she came under my care, and on December 26 I cut the rami of D 10 and 11, opening the pleura as already described. It is worthy of note that Doctor Scrimger's patient after operation passed through a week or ten days of great pain in the back and loin, which I interpret as being due to irritation of the cut central ends of the rami, before relief came. One finds the same thing, moreover, in those cases of femoral sympathectomy which ultimately are relieved. The same was now true of this second patient. But on the tenth day, she sat up in bed, and declared to a neighbor that she believed she was now well of her pain, that she felt better than for years. In the afternoon she died suddenly, as related.

The third patient was operated on in the same way by Doctor Scrimger. Her age was twenty-nine. She was admitted on November 14, 1927. For nearly ten years she had had abdominal pain. In 1919, the appendix and the right ovary had been removed. In 1920, there was a history of some kidney lesion:—"the kidney was infected"; it was "drained," and "healed up." In 1923, the abdomen was opened for adhesions, and an extensive colopexy was done on the right side. As pain was not relieved, and seemed to be in the distribution of the eleventh and twelfth intercostal nerves, these were resected posteriorly near the angle of the ribs. Pain persisted. Finally, in June, 1927, she was admitted to Doctor Scrimger's service, and he made a preliminary investigation according to Läwen; but postponed operation. The pain then grew constant, prevented sleep, caused vomiting, and for two weeks she refused food, although the pain had no relation to the taking of food. The kidney and gall-bladder were proved normal; the appendix and ovary were out of the way, also the intercostal nerves; the right colon had been lifted and fixed. Remained undoubtedly peritoneal adhesions! Should one repeat the old story and separate adhesions that had been caused only by operations for a pain that was there from the beginning? Doctor Scrimger thought not. He did a ramisectomy of dorsal eight to eleven. The patient continued to suffer for several days, after which pain left her for good.

Patients of this class have long been set down in the clinical mind as being neurasthenic or psychoneurotic, and one must still admit presumably the correctness of this view for a certain proportion of them. Yet it is clear from these reports that this field is worthy of exploration, and one may anticipate that with augmented experience it will become possible to select cases suitable for the operation, with reasonable accuracy.

We must go back to a deeper study of the anatomy and physiology of the sympathetic system on its sensory or afferent side, and, clinically, to a more exhaustive investigation of the symptom of pain in all its modalities.

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DISCUSSION OF PAPERS RELATING TO THE SURGERY OF THE SYMPATHETIC NERVOUS SYSTEM

DR. WALTON MARTIN, New York City, referred to a case reported in his paper which he thought has some bearing on Doctor Crile's paper. A baby, about two months old, was given by mistake a large dose of pituitary extract. A few hours after the administration of the drug a curious spasm of the vessels of the extremities occurred. The feet and the fingers of both hands were involved rather irregularly, turning blue-black before the death of the child. That is, there was a condition of spasm of the vessels produced by administration of the extract of the pituitary gland, such as we are accustomed to think of as associated with the over-activity of the suprarenal gland. It emphasizes the extraordinary difficulty of putting a correct value on the secretions from the internal glands. We know so little about them that it hardly furnishes a sound basis for surgical treatment.

DR. ALEXANDER PRIMROSE, Toronto, Canada, said that while discussing the beneficial results of periarterial sympathectomy in certain of these cases of failing circulation in the extremities, one may inquire as to whether or not similar results may be obtained by other means. His experience in a recent case of intermittent claudication leads him to believe that such is true.

Some little time ago the observation was made that the peripheral circulation would be improved by the use of diathermy (*vide* Gill and Moss, Lancet, October 29, 1927). Similarly the peripheral circulation is said to have been improved by the use of high voltage X-ray treatment over the region of the conus medullaris of the spinal cord. Improvement in the following case by these methods of treatment was so marked that he desired to put it on record.

W. H. P., age sixty-seven, male, for three years had noticed a progressive weakness, with aching pain in his legs. The distress was at first more noticeable in the right calf than in the left. When first seen by the speaker three years after the onset of his trouble he was able to walk fairly long distances. Thus he played eighteen holes of golf but was compelled to rest at short intervals, complaining of aching pain in the calf of each leg, with numbness and coldness of the feet. A careful analysis of his symptoms and of the local condition led his medical attendant, Dr. Samuel Mirsky, of Ottawa, to conclude that he was suffering from obliterative endarteritis with an arteriosclerotic basis. Pulsation was found in the femoral arteries but none in the popliteal, the posterior tibial or the dorsalis pedis arteries. The toes and feet were of a dusky cyanotic hue, with surface temperature somewhat lower than the rest of the leg. The right toe on its external surface showed a small indolent ulcer, in reality a gangrenous patch, possibly induced by slight trauma.

Eventually this patient suffered so much distress that his sleep was dis-

turbed. He was kept at rest in hospital and his physician employed water-cooled ultra-violet ray over the gangrenous area. Improvement was noted. The speaker saw him about this time in consultation. On his return to Ottawa, the ultra-violet ray was continued, and in addition, on January 24, 1928, treatment by diathermy was begun along with X-ray therapy over the lumbar spine. The improvement was marked. March 14, 1928, Doctor Mirsky writes: "For the past month he has been entirely free from symptoms. There has been no pain in the toe, he has been able to walk distances which before always produced pain in the calves, without any discomfort . . . the colour and temperature of both extremities is remarkably improved." April 19, 1928, he writes: "Mr. P. has been back to his usual duties for a period of one month and during this time he has been continually improving. . . . The surface temperature is markedly improved and the area where the gangrene originally was is now covered by healthy epithelium."

Dr. Fred B. Lund, Boston, Mass., said in regard to the tumors of the chromaffin glands and particularly of the carotid body, which had been discussed by Doctor Reed, that eleven years ago he reported a case of a woman who was operated on at sixteen years of age for a tumor of the left carotid body. Dr. George W. Gay was able to remove this by peeling off the carotid arteries without tying the carotid. At the age of over fifty she had come to the speaker with a tumor on the other side, which proved to be a tumor of the carotid body, which had grown very large and extended around both carotids, so that the removal of the tumor required the ligation of the common carotid and also of the external and internal carotids. No operative accidents occurred and she made a perfect recovery. The mortality of these cases at the time of this operation was very high and it was in fact so discouraging that Doctor Da Costa had advised against operating on such tumors. The high mortality came from anæmia of the brain, resulting from tying of the carotid, and also from injuries to the pneumogastric nerves, which were not infrequently damaged.

After this case Doctor Lund never saw another until this year. In the former case it was easy to make the diagnosis on the pulsation of the tumor communicated from the carotid artery and the fact that she had had a similar tumor removed on the other side. As the second operation required the ligation of the carotid on the right side, it is evidently fortunate that Doctor Gay was able to remove the tumor on the left side without ligating the vessels. This winter a second case appeared in a man of fifty, who had an abscess in his left tonsil and a small tumor under the angle of the jaw, which felt like an enlarged lymphatic gland. No pulsation was noticed in the tumor. The tonsil was removed and the tumor remained unaffected. The tumor felt lobulated and soft, in fact felt very much like a submaxillary gland. He did not make the diagnosis of a carotid body, cut down on it and found that the submaxillary gland was pushed upward and lay in front of a round, solid tumor surrounded by a tremendous plexus of veins. After tying a

large number of veins and clearing the outside of the tumor and lifting it up, the bifurcation of the carotid was lifted right outside the wound with it. It was possible to perfectly peel the tumor off the carotids, common, external and internal, without ligating any of those vessels. There was an injury to one of the lower branches of the facial nerve, which caused a slight droop of the lip for a short time, but this entirely recovered. It was probably a branch of the nerve which was caught in a ligature. The pathologist's report showed an intercarotid body.

DR. LEONARD FREEMAN, Denver, Col., said that some twenty-five years ago, shortly after Jonnesco's original communications on the subject, he did thirty-four cervical sympathectomies on eighteen patients. Sixteen of these were epileptics and two were suffering from glaucoma.

In the sixteen epileptics, the operations were done by removing the superior and the middle ganglia when the latter was present. The results were not sufficiently good for him to continue the operation, and since that time he had not done it. Of the cases operated upon one seemed to recover permanently; at least he was well five or six years afterward when he was lost sight of. One case was improved for a number of years. The remainder of the cases had no perceptible improvement.

In the glaucoma cases, one recovered permanently and is well at this time, at the end of twenty-five years. In the other one there was no influence upon the glaucoma.

In regard to the statement of Doctor Archibald that continuous fibres of the vegetative system run along the larger arteries, Doctor Freeman remarked that in 1923 a very suggestive experiment, which seems to support this, was made by Salomon and Schwartz in France. A man had gangrene of the great toe that was extremely painful. A periarterial sympathectomy was done under spinal anæsthesia. The somatic nervous system was completely paralyzed, no sensation being felt in the lower extremities, and yet when the nerve plexus surrounding the femoral artery was pinched with forceps, the man complained of violent pain in the region of the gangrene in his toe.

DR. FRANK S. MATHEWS, New York City, remarked that it seems quite definitely proven that the adrenal bodies are necessary to life, and that the part that secretes the active hormone, adrenalin, is the medulla. This part, however, is not essential as has been shown by experiment. At this we are not surprised because there are other masses of chromaffin tissue in the thorax and abdomen which may well supply the deficiency. When one adrenal is removed there is no special result—another illustration of the "factor of safety" in body organs. Two weeks later a half of the remaining gland may be removed without causing death of the animal. The animal has then been deprived of three-fourths of its adrenal cortex. The function of the cortex is admittedly obscure. Marine has removed three-fourths of the cortex and a little more—what he calls a sublethal reduction of the gland. In his animals there resulted a hypermetabolism. This is perhaps the nearest

we have come to seeing a hyperthyroidism produced in animals. No clinical exophthalmic goitre has been observed in animals, though in the thyroid gland of dogs have been seen the changes which would seem quite characteristic of exophthalmic goitre if seen in man. So far, then, as we have intimations of the function of the cortex, it acts to inhibit the thyroid and it does not seem that an operation which curtails the activity of the adrenal would be of value in exophthalmic goitre. The only other experimental work except Marine's which produced a condition resembling exophthalmic goitre is the work of Cannon in which he anastomosed the phrenic and cervical sympathetic. In his animals (cats) changes in the adrenals were noted. No subsequent work has been done by either Cannon or others along these lines. With our present knowledge it would seem more reasonable to think that the adrenal cortex has an inhibiting action and not a stimulating one on the thyroid, and hence that it is not desirable to lessen the amount of the cortex in exophthalmic goitre. An observation of some interest is that the adrenal is large in late fœtal life at a time when the thyroid activity (heat production) is in abeyance. At birth the thyroid must begin to function and the need for inhibition through the adrenal would be less.

Doctor Archibald speaks of pain in the sympathetic nervous system. It has always seemed to the speaker unfortunate that the word "sympathetic" was ever applied to that system, because it immediately suggests sensation or reflex action, whereas the physiologists usually describe the system as an efferent one. It seemed to him that it simplifies and gives an accuracy to our thinking if we consider that system as an entirely efferent one, being a means of distributing impulses that come from the spinal cord and then pass to various organs and blood vessels. Apparently there is no reflex action produced without the mediation of the cerebrospinal system. If a blood vessel is pinched, we feel pain as Doctor Archibald has shown, hence a nerve fibre carrying pain sensation must run in the wall of the vessel and for a distance at least passes with the sympathetic nerve fibres. If these fibres, however, are traced back, they pass through the sympathetic ganglia and find their nerve cell in the posterior root ganglia or in the cord and hence are more properly spoken of as belonging to the cerebrospinal system rather than to the sympathetic one. On this point of view the question of whether a nerve fibre is sympathetic or cerebrospinal is decided not on the basis of what fibres it accompanies on its way to the periphery but whether its trophic centre is located in the chain of sympathetic ganglia or whether it is located in the cerebrospinal axis. If this distinction is adopted, the so-called sympathetic or autonomic system becomes a more definite anatomical and physiological unit, being efferent in character and physiologically confined to bearing impulses over a comparatively few nerve fibres from the cerebrospinal system to the chain of ganglia which then diffuse the impulses over a large physiological distribution.

Doctor Archibald no doubt meant that these efferent impulses travel largely with sympathetic or autonomic fibres and hence he includes them with

the system. It will clarify our thinking of the autonomic system if we consider it not directly concerned with pain.

DOCTOR ARCHIBALD (in closing) said that the observation related by Doctor Freeman meant that his spinal anæsthesia did not reach so high as to block the entrance of the sympathetic fibres which came in above that point. Surgeons have increased their knowledge gradually concerning the paths of the sympathetic; for instance, we now think that the sympathetic nerves run with, or carry the fibres of deep sensibility, and that these are extremely apt to run up in the ganglionated cord and to pass into the spinal cord at a higher level than the segmental level which receives the posterior root fibre of the cerebrospinal nerves coming from the corresponding region of the periphery.

For instance, it has been said that the return of bladder function after a transverse myelitis or transverse lesion of the cord may be very possibly due to the ascent of bladder fibres in the ganglionated chain and their entrance more or less high in the thoracic region and above the level of the lesion.

Doctor Archibald said that the closing part of his paper essentially consisted in the relation, very briefly, of three cases of the operation of Von Gaza. Von Gaza, in 1923, viewing the rami communicantes as the best point of attack to relieve pain considered as coming from the abdominal sympathetic system, conceived the idea that these cases of chronic abdominal pain, in which pain recurs after a series of futile operations in the abdomen, might be relieved by a section of the rami communicantes if one could ascertain the exact level at which these pain fibres enter the cord. That knowledge of the segmental level localization is furnished by the work of Kappis and of Läwen. They were able to establish the fact that the site of the pain as described by the patient corresponded to certain segmental levels, say of dorsal eight and nine, dorsal nine and ten, and so on. For instance, the pain of a gall-bladder lesion might be really due to a state of hyperexcitability in the sympathetic system at a segmental level corresponding, let us say, to dorsal eight and nine; so that when a paravertebral anæsthesia was done, blocking the eighth and ninth intercostal nerves just outside the transverse processes and infiltrating the rami communicantes which join these nerves at that point, pain would often disappear. On the other hand it was found that the injection of the intercostal nerves in their course distal to that point would fail to relieve the pain. Doctor Scrimger, assistant surgeon at the Royal Victoria Hospital, after reading the article of Von Gaza's, operated on one case in 1926, securing for the patient complete relief. He drew my attention to the subject and I operated on a second patient who likewise got relief, but unfortunately died on the tenth day post-operatively from a double bilateral pneumothorax. And finally Doctor Scrimger operated on another patient last November with complete relief, the relief having lasted now in one case six months and in the other two years and a half. I wish to call the attention of the members to this particular experience, in case some were unacquainted

with the subject; and to emphasize the fact that for these chronic sufferers, so often bandied about as neurasthenics from clinic to clinic, there is still hope through ramisectomy, provided the cases are well chosen, and that they do not need to be referred continually back to the neurologist and the internist.

DR. WALTON MARTIN (in closing) said that he thought the most important contribution made to-day was in the paper of Doctor Adson and Doctor Judd. This contribution seems to him a real one, and in the rather hazy reports of the results one gets of various operations on the sympathetic system it stands out. The evidence furnished of the benefit gained by a division of a portion of the sympathetic system in the curious condition of congenital megalocolon seems convincing.

In regard to the relief of pain, the boy who has lost his foot has not gone on with any symptoms that would suggest that he is now having anything like a spasm of the vessels, and has had no recurring attacks of pain.

TUMORS OF THE AUTONOMIC NERVOUS SYSTEM

By Mont R. Reid, M.D.

of Cincinnati, Ohio

The accidental finding during the past year, in two cases of chronic appendicitis, of what appears microscopically to be carcinomatous growths of the appendix, and the rather recent conception that such tumors have
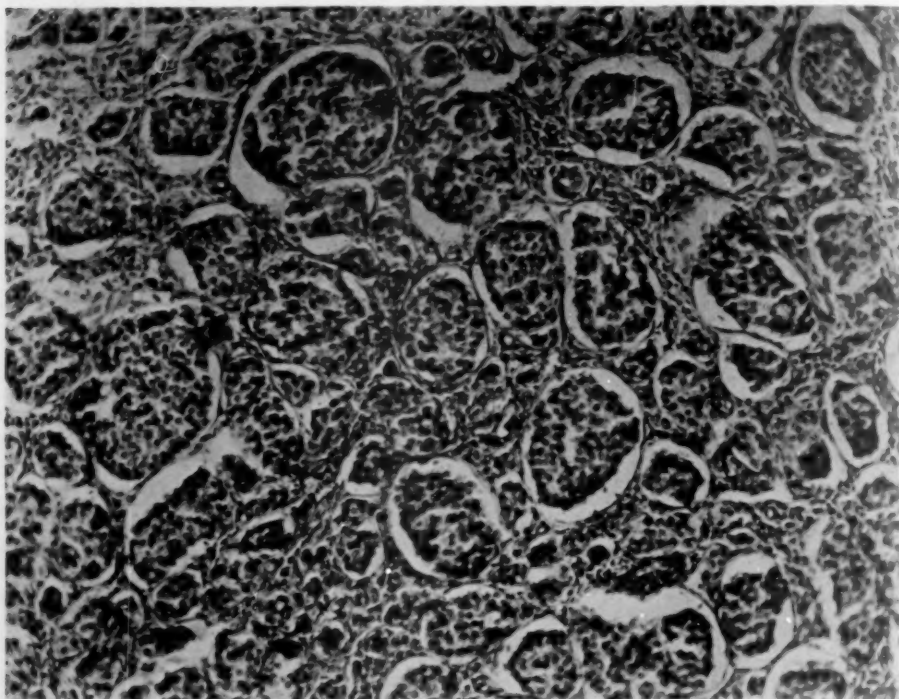
Fig. 1.—"Carcinoid" tumor of the appendix. Low power magnification. Note the similarity to Figure 8.

their origin in the chromaffin tissue of the autonomic nervous system, have led me to present to this Society a brief report on the tumors of this nervous system.

On August 5, 1927, Doctor Zinninger, our Resident Surgeon, operated upon a white woman, aged thirty years, for cholelithiasis associated with an hydrops of the gall-bladder. Before performing the cholecystectomy he removed the appendix because "it was bound down by adhesions and its tip obliterated." The external appearance of the appendix resulted in the operator's usual diagnosis of chronic appendicitis. Our pathologist, Doctor Conway, reported on the histological study of the appendix as follows: "The section from the distal portion of the appendix shows the muscular and outer coats to be apparently normal. The mucosa, however, presents a picture which is entirely unusual. The entire lumen is filled with a mass of epithelial cells. These cells are grouped in small areas irregularly placed and resting upon a dense fibrous tissue framework. The

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cells appear to be of epithelial origin, containing large darkly stained nuclei and a moderate amount of lightly stained cytoplasm. The cells are closely packed and their nuclei are generally uniform in shape and size. There is no infiltration of the outer coats of the appendix by this growth. It is limited entirely to the mucosa of the appendix." The pathologist's comment was that the growth resembled an adenoma. The histological appearance of this tumor, the ability of the cells to take up a silver stain and its resemblance to the 325 previously reported cases leave no doubt that it belongs to the group of "carcinoid" or "argentifine" tumors, or paragangliomata of the appendix.

The second case was a young girl, aged twenty-two years, who was operated upon by me on March 10, 1928. Six days previously she developed, for the first time, the
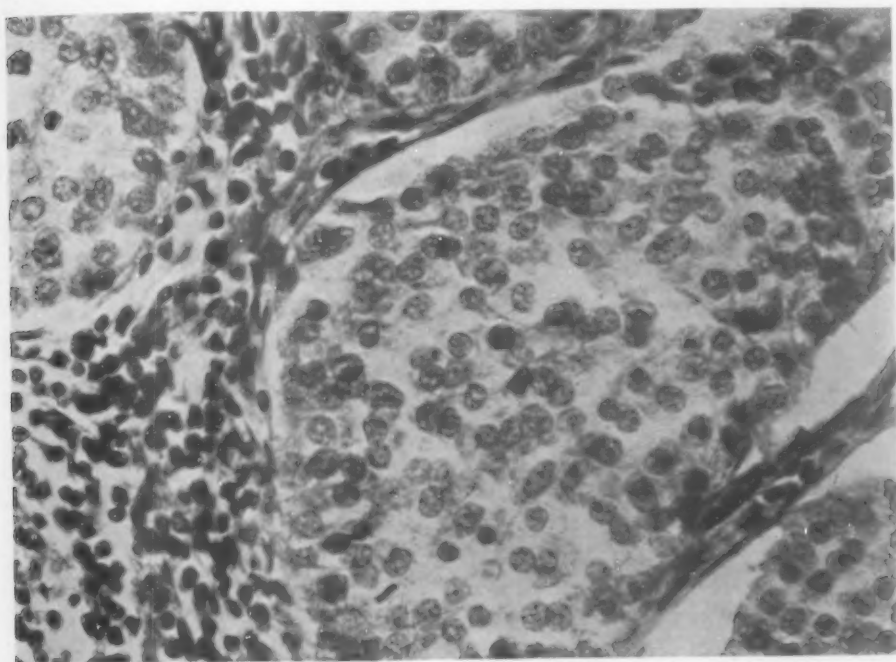
FIG. 2.—High power magnification of a paraganglioma of the appendix. Same case as shown in Figure 1.

typical symptoms and signs of an attack of acute appendicitis. When she came under my observation twenty-eight hours later, it was evident that the attack was rapidly subsiding. Five days later the re-occurrence of slight local pain and tenderness caused us to operate. To our surprise the distal third of the appendix contained a yellowish necrotic-appearing segment about one-half centimetre in length, which apparently was covered by a very thin layer of fibrin. The rest of the appendix seemed to be normal and there was no zone of acute inflammation about this segment. There were no adhesions. On opening the appendix the involved segment presented a yellowish-white surface which was rather tough. It resembled tuberculous tissue but was uniform in color and was obviously not necrotic tissue. Microscopically the growth is a typical "carcinoid" tumor of the appendix. The cells reduce silver from an ammoniacal solution. In this instance the growth involved the entire thickness of the appendiceal wall.

The color of the growth in this case was almost identical with the medulla of the suprarenal gland and was strikingly like that observed in a few cases of carotid body tumors that I have removed.

In considering the neoplasms of the autonomic nervous system, the embryological development of this system must be borne in mind. Through

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the cells composing the primitive neural tube, the so-called neurocyte, the autonomic system is related to the somatic nervous system. Certain undifferentiated cells called neuroblasts migrate ventrally from the neural tube giving origin to the sympathetic ganglia and to the chromaffin tissue. This in the human is located for the most part in the medulla of the suprarenal but is found in the so-called carotid, aortic, cardiac, tympanic and coccygeal glands, and in the gelben zellen of the Crypts of Lieberkuhn in the gastrointestinal tract.

Tumors of the autonomic nervous system may be conveniently classified as: Neurocytoma, neuroblastoma, ganglioneuroma, paraganglioma, neuroma.

From the neural epithelium arises the *neurocytoma*, a single case of which,

FIG. 3.—"Carcinoid" tumor (paraganglioma) of the appendix. The color of the lesion was yellowish.

arising in the neighborhood of the gasserian ganglion, was reported by Marchand. The neuroblasts, however, give rise to neoplasms more frequently.

Neuroblastoma is the name most commonly applied to the malignant tumor that apparently arises from the neuroblasts or undifferentiated cells from which the autonomic and chromaffin systems develop. Other terms are: Ganglioma embryonale sympathicum (Pick). Sympathicoblastoma (Pick and Bielschowsky, Bailey). Sympathigomon (Herxheimer).

This neoplasm occurs predominantly in infancy or early childhood, several having been congenital. Twenty-five, or 80 per cent. of the patients, were less than two and one-half years old, but three cases (Ritter and Meltzer) have recently been reported in patients over forty years of age.

The site of predilection is in the suprarenal gland, as shown by the fact that in twenty-seven of the cases the primary growth was found within this organ. In one case, both suprarenals were involved. In the remaining cases, the primary sites were in the sympathetic chain, the coccygeal gland, the uterus, upper jejunum and the nasal cavity.

The primary growth in neuroblastoma is usually quite small, though occasionally it may become very large. From very small, primary tumors (8 mm. diameter in one case) metastases in the liver, lungs, lymph glands, etc., may occur and reach a considerable size. The smaller tumors may be confined to

the medulla and thus present simply as an enlargement of the suprarenal gland. The larger tumors and metastases are nodular masses of rather firm consistency. Gross section shows them to be surrounded by a thin layer of fibrous tissue and to contain numerous thin-walled vessels. The cut surface is glistening white in color and soft in consistency and from it a pearly juice can be expressed. Intermingled with the glairy white tumor tissue are a variety of colors—orange, red and black, such as are often seen in xanthoma —which are due to hemorrhage, the blood pigment being in various stages
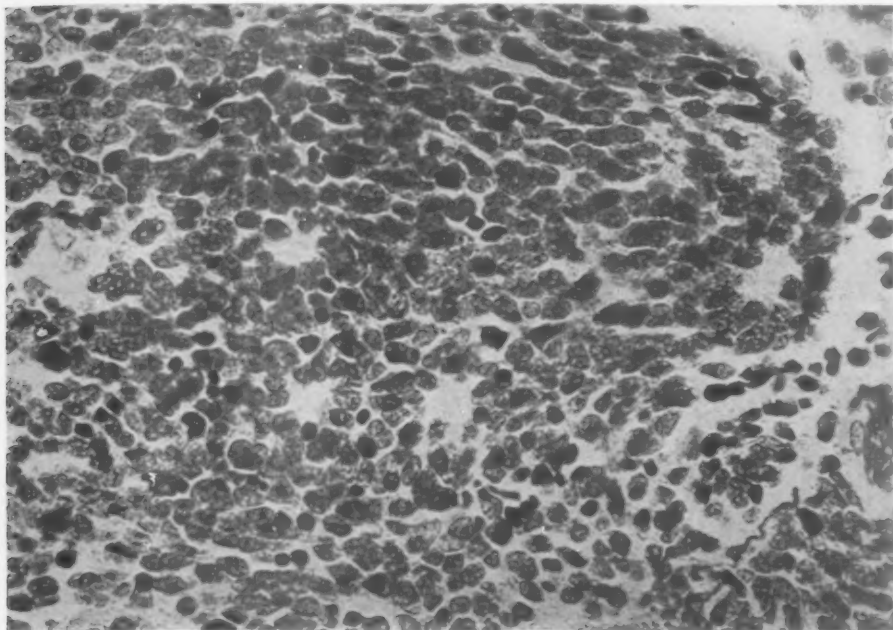
Fig. 4.—Histological appearance of a neuroblastoma.

of degeneration. In the larger nodules central necrosis occurs, giving rise to cavities filled with clear or brownish fluid.

Microscopically the tumors are alveolar in topography, the septa consisting of delicate connective tissue and thin-walled blood-vessels. The cytology of the tumor cells is somewhat variable, all stages of cells from neuroblasts proper to more mature and even differentiated ganglion cells being found in certain tumors. The predominant cells in the pure neuroblastoma are small, being little larger than the lymphocytes, and contain a relatively large, deeply chromatic nucleus with but a minute amount of protoplasm. In the most typical growths, certain of these cells are arranged in rings surrounding a central mass of fibres, the so-called "rosette" formation, a structure particularly characteristic of this type of neoplasm.

The cytology seems to vary with the rapidity of progress of the growth and the age of the host. Thus the more rapidly growing tumors occurring in the new-born or very young infants, are made up almost entirely of the

small neuroblast type of cell, while in older patients or less malignant growths, mature ganglion cells with fibril formation may be seen (Landau). Indeed, neuroblastomata and ganglioneuromata may occur in juxtaposition or may be intermingled in the same tumor. These fibrils have been thought to be nerve fibres, but their failure to stain with silver tannate by appropriate methods argues against this point of view.

Metastases from the primary growth extend first to the neighboring lymph-nodes, and thence to the liver, bony thorax and bones of the calvarium
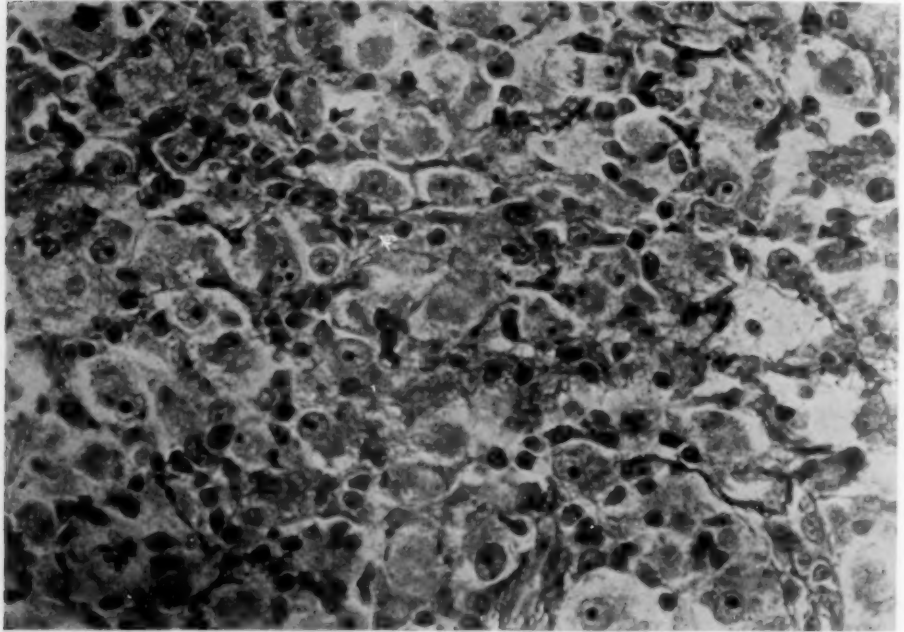
FIG. 5.—Histological appearance of a ganglioneuroma. Note the large ganglion cells.

and orbit, the spread being apparently by the lymphatic channels. But the widespread liver and lung metastases such as are seen following dissemination by way of the blood stream also occur.

In a small percentage of the cases the presence of a tumor in the supra-renal medulla is heralded by the symptoms of Addison's disease, notably asthenia and cutaneous pigmentation. However, in the larger proportion of the cases the growth has given little evidence of its presence until wide-spread metastases have produced pressure effects either in the abdomen or intra-cranial contents.

Two clinical types have been differentiated; the one which because of intra-cranial or retro-orbital metastases, presents with exophthalmos, epilepti-form seizures or paralyses, and a second group, in which progressive enlarge-ment of the abdomen is the first symptom.

The primary diagnosis of neuroblastoma in the absence of a biopsy is almost impossible, but this growth should be suspected, particularly in young

children, when a mass is found in the region of the suprarenal gland with characteristic metastases, or the liver is markedly enlarged without marked ascites. The presence of Addison's syndrome would be of definite aid in the early diagnosis but this unfortunately is present in but a small number of the cases.

The prognosis in these cases is distinctly bad, only one patient, reported by Lehman in 1917, having been successfully operated upon. In that instance, the tumor was confined to the suprarenal gland, which had become enlarged and pedunculated and could thus be completely excised.

In all but a few of the reported cases the tumor had already reached such a size or had metastasized so widely, that complete removal was impossible, but in the one really operable case, the tumor was successfully removed. No statistics are available upon the effect of radiation on these tumors.

Ganglioneuroma is a relatively benign neoplasm arising from the ganglionic elements of the autonomic nervous system. In contrast to the neuroblastomata, the ganglioneuromata occur more commonly in adults, the average age in fifty-two cases being nineteen years. The youngest reported patient was four years of age and the oldest seventy-six. Sixty-two per cent. of the cases occurred in females, while only thirty-eight per cent. were in males. Of twenty-nine cases in which the side

FIG. 6.—Paraganglioma of the carotid body (carotid body tumor). Duration of tumor eleven years. A diagnosis of carotid aneurism was made six years before removal of the tumor.

was indicated, twenty-five occurred on the left side of the body.

These tumors vary considerably in size, the reported cases varying from the size of a hen's egg to that of a child's head or larger. In Sauerbruch's case (reported by Brunner) the tumor measured 17 x 12 x 8 cm.

Due to their large fibrous content they are firm in consistency, presenting in the gross many of the characteristics of a fibroma. In some instances, the outer layers of the tumor compose a very firm, almost cartilaginous shell enclosing a mass of softer tissue. The cut surface is gray and glistening and appears to be relatively avascular, with fibrous tissue septa dividing the tumor into smaller lobules. Microscopically these neoplasms show a rather coarse, reticular arrangement of fibrous tissue in the interstices of which are contained strands of non-medullated and medullated nerve fibres. In the majority of cases the former type predominates. Intermingled with these fibres are found multipolar ganglion cells varying in number in different tumors and many of them showing signs of degenerative changes, such as vacuolization, etc.

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The ganglioneuromata are usually benign, as shown by the fact that they are of slow growth and may reach a considerable size before giving rise to symptoms. In Sato's case, the tumor was known to have been present for sixteen years before its operative removal, and several authors (Borst, Beneke, Ohse, Braun, Kreche and Brunner) have reported cases in which the tumor was as large as a child's head or larger. Also, in at least one case (Busse-Kredel), re-investigation of a ganglioneuroma, incompletely removed at operation five years previously, failed to reveal any recurrence.
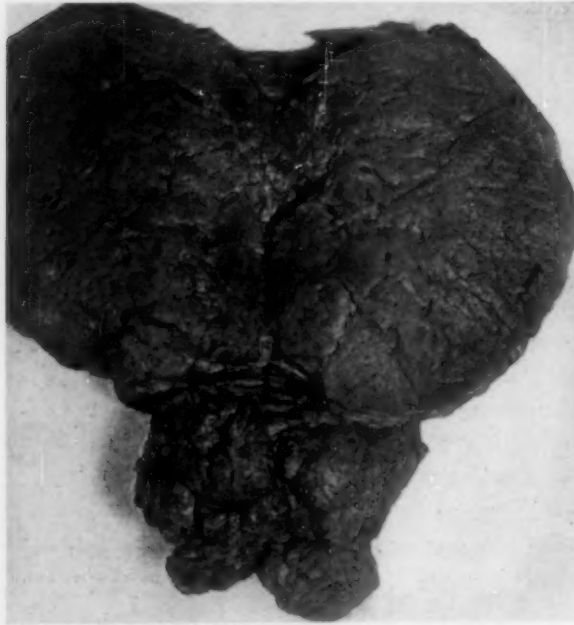
Fig. 7.—Carotid body tumor removed from the patient shown in Figure 6.

In certain of the reported cases, ganglioneuromata seem to have possessed malignant characteristics. Thus, in Beneke's case, cell types and topography suggestive of neuroblastoma were found, and Berner and Miller found metastases from such a tumor in the neighboring lymph-nodes. Jacobstahl noted liver metastases, and Seefelder described metastases from a pelvic ganglioneuroma to the lymph-nodes, bones and soft parts.

These cases have been taken to indicate malignant degeneration of ganglioneuromata. However, since combinations of neuroblastoma and ganglioneuroma are known to exist, it would seem more rational to consider these cases as neuroblastomata in parts of which more mature elements, *i.e.*, differentiated ganglion cells, are to be found. Indeed, it seems altogether likely that we have all gradations between pure neuroblastomata and pure ganglioneuromata and that the degree of benignancy corresponds quite accurately with the degree of differentiation to be found in the individual tumors.

The rather rare occurrence of ganglioneuromata in connection with peripheral nerves may be due to anomalous development, but is also to be explained on the basis of Alt's work in which he found numerous ganglion cells in the brachial and lumbo-sacral plexuses in dogs, cats, etc. The diffuse subcutaneous distribution in the case of Kredel-Beneke may have originated from the perivascular plexuses in which Glaser has demonstrated ganglion cells.

Ganglioneuromata produce relatively few symptoms and are often found

in the course of some secondary condition. They sometimes produce paralysis by pressure. Thus deQuervain noted ptosis and anisocoria in a cervical case, and Busse has described Kredel's case in which a similar tumor in the lumbar region produced paralysis of the leg, bladder and rectum. Occasionally, as in Loretz's case, a tumor springing from the gray ramus may invade the spinal canal through the intervertebral foramina, and produce pressure on the cord or cauda equina while at the same time assuming proportions retroperitoneally or behind the pleura.

Since these tumors produce no intrinsically characteristic symptoms one can readily understand why a definite diagnosis in the absence of histological examination has never been made. Pressure symptoms attributable to the autonomic system should suggest such a diagnosis but since so many other and more common lesions may produce sympathetic paralysis, such evidence is only contributory. Of twenty cases operated upon, seventeen were cured at the time of the last report, while only three died, two from direct effects of the operation and one due to malignant changes in the tumor with metastases. In contrast to the neuroblastomata we see, therefore, that the ganglioneuromata are quite benign in their course and offer a relatively good prognosis.
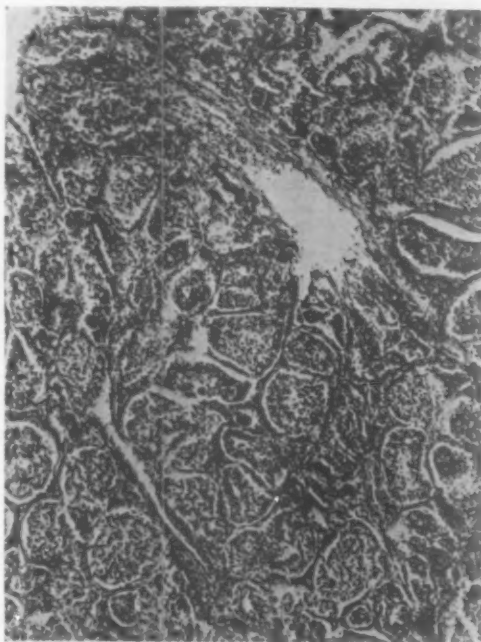
FIG. 8.—Histological section of the carotid body tumor shown in Figure 7.

Paraganglioma.—While one branch of the neuroblast tree gives rise to the sympathetic ganglion cells, the other differentiates into the cells which, by virtue of their chemical affinity for the salts of chromium, are spoken of as chromaffin cells. To the organs composed of chromaffin tissue, Kohn has given the name of paraganglia, and neoplasms of this tissue are called paragangliomata (Alezais and Peyron).

While, theoretically, paragangliomata may arise from any of the collections of chromaffin tissue, the greater number, by far, arise in the suprarenal medulla, the carotid gland, and the Gelben Zellen of the gastro-intestinal tract.

The paragangliomata of the suprarenal medulla are relatively rare; only about seventeen cases have been recorded since the first case was reported by Berdey in 1892. All reported cases have been quite benign and symptomless, being for the most part autopsy curiosities. As a rule, the tumors are small, varying from the size of a pinhead to aggregations a few centimetres in

diameter. In the gross the tumor appears as an enlargement of the supra-
renal gland, which on section, is seen to be due to a brownish-gray mass dis-
tending the cortex. Microscopically, the tumors are composed of epithelial
cells which are arranged in cords along delicately anastomosing capillaries
and which, when stained with chrome salts, take a brownish color.

In certain cases, notably those reported by Hedinger, Manasse, Marchetti
and Suzuki and Zechmer, sympathetic ganglion cells and their less mature
precursors have been found in the tumors, and, in these cases, the tumor
was invading the cortex in a way which would indicate at least potential
malignancy. The association of
paraganglioma of the adrenal med-
ulla with neurofibromatosis in
fourteen reported instances (Herx-
heimer-Kawashima, Suzuki and
Zeckmer) is an interesting clinical
observation.

FIG. 9.—The dotted line indicates how the bifurca-
tion of the carotid artery was embedded in a paragan-
glioma of the carotid gland.

More numerous and far more
important from the surgical stand-
point are the paragangliomata of
the carotid gland. Marchand, in
1891, was the first to call attention
to this tumor, while Paltauf, in
1892, reported four additional
cases and, through his paper,

established the condition as a clinical entity. A survey of the literature
reveals some 111 reported cases.

Tumors of the carotid gland are found largely in adult life. The average
age is forty-one years, with the extremes in age of seven and seventy-four
years. Only six such tumors have been reported in patients under twenty
years of age.

In most instances the tumors had been present for some time before opera-
tion; in but fourteen instances had the tumor been present less than one year
and in almost 60 per cent. of the cases, a mass had been noted for more than
three years. Three patients dated the appearance of the growth from a time
more than thirty years previous to operation. In many of the cases, how-
ever, in which the tumor had been present for more than a year or so, a
more rapid growth during the months preceding operation was noted.

For the most part the growth of the tumor is symptomless until it comes to
cause pressure on the surrounding nerves or upon the pharynx or œsophagus.
Relatively small tumors may press upon certain nerves. The vagus was
most commonly involved (fourteen times); the hypoglossal next (seven
times); the cervical sympathetic (five times); the glossopharyngeal (five
times); and spinal accessory (twice). In some instances the patient may
complain of pain in the throat, ear or base of the skull, or there may be
atrophy of the corresponding half of the tongue or dysphagia. The latter

symptom may also be due to protrusion of the growth into the pharynx. Pressure upon the sympathetic chain may also give rise to anisocoria or enophthalmos, and in a few instances there has been aphonia and dyspnœa due to pressure from large tumors.

Tumors of the carotid body have been variously regarded as peritheliomata, endotheliomata, epitheliomata, perithelial angiosarcomata or adenomata, due no doubt to slight variations in the histological structure. However, while hyperplasia or neoplastic growth of the structural elements of the carotid body aside from the chromaffin tissue does occur, the behavior of these tumors and the general similarity of their gross and histological appearance would seem to indicate that in most carotid body tumors, we are dealing with a certain pathological entity. Certain cases, notably two of those of Gilford and Dobromyslov's case seem to have been sarcomata, while Gilford has also reported a case which was probably a carcinoma.

FIG. 10.—The gelben zellen in the Crypts of Lieberkuhn of the appendix, darkly stained with silver. (After Forbus.)

Grossly, these tumors present as nodular masses which are of firm consistency and even texture, characteristics which prompted the suggestion of the appelation of "potato tumors" by Hutchinson and Gilford. On section, they are usually well encapsulated with fibrous tissue and the cut surface usually presents a yellow or orange color, varying to red with the vascularity of the tumor. In many instances, the great vascularity has suggested angio-sarcoma or even aneurism. The adjacent lymph-nodes are occasionally agglomerated with the tumor but are rarely involved by the growth.

Histologically, an alveolar topography is quite characteristic, the growth being composed of polyhedral granular cells arranged in compact groups and surrounded by hyperplastic capillary endothelium. The amount of stroma varies but is often scanty, the characteristic cells being in intimate contact with the capillary endothelium.

Because of the site of the carotid gland, tumors arising from it present a rather definite clinical picture and important neighboring structures so soon become involved that the surgical attack upon these tumors furnishes a very difficult problem.
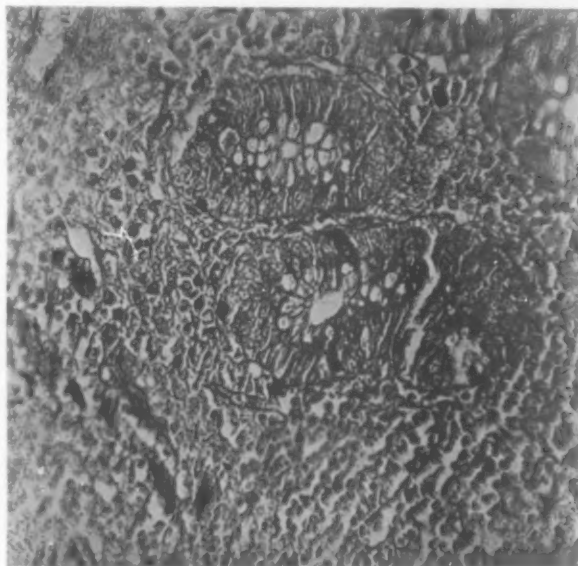
Keen, writing on these tumors, mentions the following points which may aid in the diagnosis: (1) The position at the bifurcation of the carotid artery, (2) movability laterally but not vertically, (3) ovoid shape, (4) smooth and not lobulated, (5) single, (6) transmitted pulsation, (7) bruit and thrill, (8) bulging of the wall of the pharynx, (9) pupils occasionally constricted, (10) slow growth, (11) long duration, (12) a rather firm elastic consistency. Speaking negatively he says they are: (1) Not tender, (2) not painful and (3) the deformity is the main complaint.

The position of the artery in these cases deserves further comment. Whereas other cervical growths may dislocate the artery, they usually leave it freely movable. In carotid body tumors the carotid artery is caught, fixed and carried lateralward so that it lies in a groove on the lateral or antero-lateral aspect of the tumor.

Since many of these tumors are extremely vascular, a palpable pulsation and associated bruit are frequently evident, and have been commented upon in twenty-two cases.

The surgical removal of carotid body tumors is fraught with a considerable danger and difficulty, because the frequent involvement of the carotid artery in the substance of the growth necessitates the ligation or excision of this vessel or even the entire neurovascular bundle. Of forty-three cases in which it was necessary to ligate the carotid artery, nineteen or forty-four per cent. died. In addition, two other patients suffered hemiplegia. The concomitant ligation of the common carotid and internal jugular in fifteen cases was attended with a mortality of 54 per cent.

The mortality in the collected cases was about 40 per cent., certainly a high rate for an operation performed in the greater number of instances for cosmetic reasons. Such considerations have led several surgeons—Da Costa, Reclus and others, to advise against operation in the simple cases where a definite diagnosis has not been made before fixation and involvement of the neurovascular bundle has taken place.

Obendorfer (1907), separated from the true carcinomata of the gastro-intestinal tract, a group of neoplasms to which he applied the name of *carcinoid tumors,* which, according to our classification, are called paragangliomata.

Hubschmann in 1910 (*Revue. med. de la Suisse rom.,* 1910, vol. xxx, p. 317), suggested that these tumors had their origin in the so-called "Gelben Zellen" of the Crypts of Lieberkuhn, the chromaffin character of which had been proven by Schmidt in 1905. Gosset and Masson in 1914, (*Presse med.,* vol. xxii), studied these cells and the carcinoid tumors and concluded that the tumor cells are probably identical with the chromaffin tissue of the paraganglia. While the idea of the origin of the carcinoid tumors from chromaffin tissue has not been universally accepted, the findings of Gosset and Masson have been confirmed by other authors, notably by Hasegawa (1923), Damsch (1924), and Forbus (1925), and the weight of evidence

seems to point to their endocrine origin. As such, they deserve consideration among the tumors of tissue related to the autonomic nervous system.

Pathologically, these tumors present as single or multinodular enlargements, occurring most commonly in the appendix and ileum, but being also found elsewhere in the gastro-intestinal tract. Occasionally they appear as a bulbous enlargement of the distal portion of the appendix. The incidence of their occurrence in appendices removed at operation is estimated at 0.4 per cent. The tumors are found in the submucosa but may extend into the muscularis or more rarely into the mesentery. Microscopically they are made up of rather round, oval or low cylindrical cells with round or oval nuclei, which stain quite deeply but do not exhibit much variation in size nor many mitotic figures. These cells are found in nests or alveoli, surrounded by interlacing trabeculæ of fibrous or smooth muscle tissue. Because of the peculiar ability of certain of the cells to reduce silver from ammoniacal solution, the name of argentaffine tumors has been suggested. Clinically, these tumors are quite benign and seldom, if ever, produce symptoms of themselves.

Neuromata may develop in the sympathetic nerves just as well as in the peripheral nerves. Massary and Valser (*Soc. med. des Hopitaux,* January 29, 1923), reported a case of a tumor in the wall of the stomach, which they considered to have been derived from Schwann's syncytium, and because of the identity of this tissue with the central neuroglia, they regarded it as a glioma. The neuromata of the sympathetic nerves have been studied by Masson (*Thesis,* Paris, 1909), and Quirin (*Thesis,* Paris, 1921) has described the embryonal sympathomata. Both these classes of neoplasms present as non-malignant tumors, which occur more commonly in the uterus than in other viscera.

Careful study by Masson and by Askanazy, of the proliferation of the nerve elements about the margins of gastric ulcers and in the walls of previously inflammed appendices—particularly those of the chronic obliterative type—has convinced these authors that, in some instances, such an overgrowth may reach a true neoplastic grade. Dupuy (*International Clinics,* vol. iv, December 25, p. 164) has described a case of ulceration and chronic perforation of the gastric wall, in which there was a considerable hyperplasia of the cells and fibres composing Auerbach's plexus.

Leriche, Bettman and others, who have performed periarterial sympathectomy on the iliac arteries or upon the abdominal aorta, for intractable pelvic pain, base the rationale of the operation upon the idea that the pain is caused by neuromata formed in connection with the pelvic or uterine nerves —such as have been demonstrated in the uterus by Masson.

SUMMARY OF THE TUMORS OF THE AUTONOMIC NERVOUS SYSTEM

1. In the appendix 325
2. In the carotid body 111
3. In the suprarenal medulla 70

With the two cases of "carcinoid" tumors of the appendix reported in this paper, we have collected 325 cases of paragangliomata of the appendix. In reviewing the literature, we have found twenty-five cases in which the appendiceal growth was definitely a carcinoma, some of which were of the colloid type. At the Mayo Clinic the incidence of appendiceal tumors was 0.44 per cent. among the first 5000 cases of appendectomy reported; 0.6 per cent. among the next 3039 cases. One case of the sixty-four appendiceal tumors reported from this clinic was definitely malignant. Stewart and Taylor report a "carcinoid" tumor of the appendix that caused a metastatic nodule in the pelvis, and claim to have found in the literature seventeen cases of "carcinoid" tumors associated with metastases. I agree with Forbus who doubts if true paragangliomata of the appendix and gastro-intestinal tract ever metastasize. This author has called attention to a peculiar adeno-carcinoma which superficially resembles "carcinoid" tumors but does not give any of the characteristic chemical or staining reactions. It will, however, produce extensive metastases.

We have collected 111 reported cases of carotid body tumors which, we believe had their origin from the chromaffin cells. This does not include the few cases of malignant tumors that have apparently developed in the stroma of this gland. Of the 111 cases, 110 may be classified as paragangliomata and one as neuroblastoma. Birniois states that no improvement has resulted from radiotherapy and also, that no distant metastases have ever been observed. Collison and Machenty mention one case from the literature, in which metastases to the liver occurred. We could not find the original report of this case.

Of the seventy tumors of the suprarenal medulla, forty appear to be neuroblastomata; thirteen ganglioneuromata; and seventeen paragangliomata. The neuroblastomata were highly malignant, the other tumors were relatively benign.

Of the small intestine there are reported two neuroblastomata and fifteen paragangliomata ("carcinoid" tumors).

One neuroma and one peripheral glioma (neuroblastoma) are reported as occurring in the stomach.

There are eighteen tumors of the autonomic nervous system, which have been located in the region of the central nervous system—five neuroblastomata and thirteen ganglioneuromata. Of the ganglioneuromata, three were in the cerebrum; two in the cerebellum; two in the tuber cinerium; one in the

medulla; one in the gasserian ganglion; one in the pineal body; two in the dura and ependyma; and one in the spinal canal.

Eight tumors of the cervical sympathetic chain have been recorded—two neuroblastomata and six ganglioneuromata.

Eleven tumors of the thoracic sympathetic chain have been reported—three neuroblastomata and eight ganglioneuromata.

Of the twenty-seven tumors of the abdominal sympathetic chain, seven were neuroblastomata; sixteen ganglioneuromata; and four paragangliomata.

Of the twenty-one miscellaneous tumors listed in the chart, there are five neuroblastomata: one in the retina, one in the nasal cavity, one in the uterus and two in the coccygeal gland; twelve ganglioneuromata—one in the spheno-maxillary fossa, one in the eye-lid, one in the nares, one in the mesentery, three in the pelvis, one in the sacral region, two in the subcutaneous tissue, one in the chin and one in the knee-joint; and four paragangliomata—one in the aortic ganglion, one in the retroperitoneal tissue and two in the upper pole of the kidney (possibly in the suprarenal gland).

Very little has been written about neuromata of the autonomic nervous system. Consequently our statistics do not convey any accurate idea as to the incidence of this condition.

TUMORS OF THE SUPRARENAL MEDULLA

Classified According to Type, and the Authors Reporting Them.
Neuroblastomata

Dalton, 1885	1	Hertz and Secher, 1918	1
Marchand, 1891	1	Wolbach and Morse, 1918	3
Orr, 1900	1	Gunby, 1920	1
Amberg, 1904	1	Carter, 1921	3
Richards, 1905	1	Van Dam, 1924	2
Kuster, 1905	1	Boyd, 1926	1
Lapointe and Lacene, 1907	1	Lederer, 1926	1
Tileston and Wolbach, 1908	1	Bendixes and Lamb, 1926	1
Wright, 1910	1	Meltzer, 1926	2
Landau, 1912	2	Kawatin and Twiss, 1927	3
Herxheimer, 1913	1	Saphis, 1927	1
Wahl, 1914	1	Gibson, 1927	2
Dunn, 1915	1	Sturtevant and Heller, 1927	1
Glosmet, 1915	1		—
Harbitz, 1915	2	Total cases	40
Lehman, 1917	1		

Ganglioneuromata

Weichselbaum, 1881	1	Oberndorfer, 1907	1
Busse and Kredel, 1898	1	Miller, 1908	1
Schmidt, 1899	1	Hook, 1911	1
Bruchanow, 1899	1	Dunn, 1915	1
Beneke, 1901	1	Berner, 1922	1
Fabris, 1903	1		—
Ribbert, 1904	2	Total cases	13

Paragangliomata

Berdez, 1892	1	Wegelin, 1912	1
Manasse, 1896	1	Thomas, 1913	1
Marchetti, 1904	1	Ewing, 1922	1
Laignel Lavastine, 1908	1	Zweiker, 1925	1
Alezais et Peyron, 1911	1	Bonnamour et al, 1927	1
Suzuki, 1910	3	Oberling et Jung, 1927	1
Hedinger, 1911	1		—
Kawashima, 1911	1	Total cases	17
Herde, 1912	1	*Grand total*	*70* Cases

DISTRIBUTION OF TUMORS OF THE AUTONOMIC NERVOUS SYSTEM

Classified According to Type, and the Authors Reporting Them.

Neuroblastomata

Location	Author	Number of Cases
Central nervous system	Marchand, 1907	1
Central nervous system	Bailey and Cushing, 1926	3
Central nervous system	Silverberg, 1926	1
Retina	Boyd, 1926	1
Cavity of nose	Wolbach, 1911	1
Cervical sympathetic chain	Martius, 1913	1
Cervical sympathetic chain	Capaldi, 1927	1
Thoracic sympathetic chain	Anderson and Sheenan, 1923	1
Thoracic sympathetic chain	Cabot, 1927	1
Thoracic sympathetic chain	Capaldi, 1927	1
Abdominal sympathetic chain	Hecht, 1909	1
Abdominal sympathetic chain	Schilder, 1909	1
Abdominal sympathetic chain	Wright, 1910	1
Abdominal sympathetic chain	Landau, 1912	1
Abdominal sympathetic chain	Anitschkow, 1913	1
Abdominal sympathetic chain	Boyd, 1926	1
Abdominal sympathetic chain	Karelitz, 1927	1
Uterus	Pick, 1912	1
Coccygeal (gland) region	Alezais and Imbert, 1907	1
Coccygeal (gland) region	Harbitz, 1915	1
	Total cases	22

Ganglioneuromata

Central nervous system (cerebrum)	Worcester, 1901	1
Central nervous system (cerebrum)	Dumas, 1904	1
Central nervous system (cerebrum)	Schmincke, 1910	1
Central nervous system (cerebellum)	Achucarro, 1913	1
Central nervous system (cerebellum)	Lhermitte, 1920	1
Central nervous system (tuber cinerium)	Robertson, 1915	1
Central nervous system (tuber cinerium)	Greenfield, 1919	1
Central nervous system (medulla)	Pick and Bielschowsky, 1911	1
Central nervous system (gasserian ganglion)	Risel and Zwickaw, 1909	1
Central nervous system (pineal body)	Cushing and Wolbach, 1927	1
Central nervous system (dura and ependyma)	Haenel, 1899	1
Central nervous system (dura and ependyma)	Bielschowsky, 1925	1

Ganglioneuromata—Continued

Central nervous system (spinal canal)	Cushing and Wolbach, 1927	1
Spheno-maxillary fossa	Dunn, 1915	1
Eye-lid	Krauss, 1911	1
Nares	Axel Key, 1879	1
Cervical sympathetic chain	Benda, 1904	1
Cervical sympathetic chain	Glinski, 1906	1
Cervical sympathetic chain	Woods, 1906	1
Cervical sympathetic chain	Freund, 1913	1
Cervical sympathetic chain	Sommerfelt, 1920	1
Cervical sympathetic chain	Stout, 1924	1
Thoracic sympathetic chain	Loretz, 1870	1
Thoracic sympathetic chain	Tschistowitsch, 1908	1
Thoracic sympathetic chain	Friedrich, 1911	1
Thoracic sympathetic chain	Rosenson, 1923	1
Thoracic sympathetic chain	Brunner, 1924	1
Thoracic sympathetic chain	Stout, 1924	1
Abdominal sympathetic chain	Busse, 1897	1
Abdominal sympathetic chain	Cripps and Williamson, 1899	1
Abdominal sympathetic chain	Beneke, 1901	1
Abdominal sympathetic chain	Rosenbach, 1901	1
Abdominal sympathetic chain	Glockner, 1902	1
Abdominal sympathetic chain	Ohse, 1906	1
Abdominal sympathetic chain	Falk, 1907	1
Abdominal sympathetic chain	Braun, 1908	1
Abdominal sympathetic chain	Oelsner, 1908	1
Abdominal sympathetic chain	Miller, 1908	1
Abdominal sympathetic chain	Sato, 1912	1
Abdominal sympathetic chain	McNaughton-Jones, 1912	1
Abdominal sympathetic chain	Jacobsthal, 1909	1
Abdominal sympathetic chain	Peters, 1913	1
Abdominal sympathetic chain	Adams, 1914	1
Abdominal sympathetic chain	Berner, 1922	1
Mesentery	Peterson, 1913	1
Pelvis	Beneke, 1901	1
Pelvis	Schorr, 1910	1
Pelvis	Stoeckel, 1923	1
Sacral region	McNaughton-Jones, 1912	1
Subcutaneous tissues	Knauss, 1898	1
Subcutaneous tissues	Kredel and Beneke, 1902	1
Chin	Chiari, 1898	1
Knee-joint	Hagenbach, 1910	1

Total cases 55

Paragangliomata

Aortic ganglion	Stangl, 1902	1
Retroperitoneal	Vecchi, 1905	1
Upper pole kidney (suprarenal?)	Weisel, 1902	1
Upper pole kidney (suprarenal?)	Stoerk	1

Total cases 4

(*Grand total*) .... 81 Cases

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OPERATION FOR THE RADICAL CURE OF TRIGEMINAL[*] NEURALGIA

ANALYSIS OF FIVE HUNDRED CASES

By Charles H. Frazier, M.D.

of Philadelphia, Pa.

Foreword by William G. Spiller, M.D.—It is a pleasure to write a foreword to an article by Dr. Frazier on tic douloureux. In the years 1901, 1902, 1903 and 1904 he and I published a series of papers presenting the results of our studies on the trigeminal nerve.

The subtotal division of the sensory root of this nerve is a great advance in the surgery of tic douloureux. This operation was devised and first performed by Frazier in 1915, and in 1925 (*Archives Neurol. and Psychiat.*, March, 1925) he recorded twenty-five cases in which he had performed it successfully. It had solid foundation. In the paper published by him and myself in 1901 (*Phila. Med. Journal*, Dec. 14, 1901) where he described the first case in which the total division of the sensory root was done deliberately with complete success in substitution for removal of the ganglion, statements were made by me regarding the anatomical arrangement of the fibres in the sensory root of dogs on which operation had been performed. The sensory root in a few dogs was not completely divided in its inner portion, and from a study of the spinal root in the medulla oblongata conclusions were drawn relative to the definite arrangement of its fibres. I was able to show that the nerve fibres of the sensory root in both its intracerebral and extracerebral portions maintain the same relative positions throughout the course of this root. This fact also was elaborated in our paper published in the *Journ. Amer. Med. Assoc.*, Oct. 1, 1904, and the situation of the fibres of the ophthalmic division was determined.

One might suppose that Frazier as a result of this experimental work in 1901 would have suggested the subtotal division of the sensory root. At that time we did not have satisfactory assurance that regeneration of the sensory root was impossible, and in 1903 we published the results of further experimental studies to settle this point. We found that the posterior spinal roots in the dog when cut did not regenerate (*University of Penna. Med. Bul.*, June, 1903). It was probable that the sensory root of the trigeminal nerve being similar would behave in a like manner.

Although we had received very generous recognition of our work by Van Gehuchten (*Le Névraxe*, vol. v) we felt that it was necessary to establish the operation of total division of the sensory root upon a firm basis as a proper surgical procedure, and it was not until Frazier had performed this operation many times, and had noticed in his cases the usual escape of the ophthalmic division in the pain of tic douloureux that he could venture

[*] Read by title.

to spare the inner portion of the sensory root. The paper by Frazier and Whitehead (*Brain,* vol. xlviii, part iv, 1926, p. 458) established further the anatomical divisions of the ganglion and sensory root by embryological development.

It may be that the ophthalmic division of the trigeminal nerve is phylogenetically older than the other two divisions, although I do not have proof of this, and is therefore more resistant to pain, as phylogenetically new tissue is more susceptible to adverse conditions. This possibility is suggested by the fact that Whitehead found that the ophthalmic portion is more precocious in its development. The cells in this region develop their fibre processes earlier and the cells become arranged in clusters sooner than do the cells of other regions.

It was in 1919 that Frazier reported that he had succeeded in operating with preservation of the motor root, but in our paper published in 1901 cited above I mentioned that he had saved the motor root of the dog in operation on the sensory root, and that the motor root in man probably would likewise be saved, yet in 1902 this seemed impossible to Keen and Frazier (footnote, *Phila. Med. Journ.,* Oct. 25, 1902, Frazier and Spiller). The preservation of the motor root is a great advance in the surgery of the trigeminal nerve, as shown by Frazier (*Journ. Amer. Med. Assoc.,* Nov. 20, 1926, vol. lxxxvii, p. 1730).

OPERATIVE DISCUSSION BY DOCTOR FRAZIER

IN THE Neurosurgical Clinic of the University of Pennsylvania Hospital more than 500 major operations have been performed for the relief of major trigeminal neuralgia. To be precise, the exact number of major operations (April 30, 1928) performed is 511. From the first to the last operation twenty-seven years have elapsed and during this period there has been an unusual wealth of material for observation and treatment; altogether upwards of 1200 cases of major neuralgia, not including some 248 of the atypical forms. A number of contributions have appeared from the clinic during the period, touching on various aspects of this subject, but it seems, upon the completion of these 500 major operations, a fitting time to summarize our impressions of this disease, to write up the experience of the operator in matters of technic, to record our knowledge of the patients' reactions before and after the operation. This purports to be a chronicle of events for this quarter of a century, as they relate to the problem of trigeminal neuralgia only in this clinic.

Clinical Conceptions.—I have nothing to add to that description of Fothergill of the year 1776. It is a vivid, accurate description of what might be said to be a prototype. We should accept Fothergill's picture as a faithful portrayal of the disease. There are, however, many side lights. There is a tremendous variation in the severity of the pain. But insofar as one can judge from the observation of a patient during his paroxysms, in the minority rather than in the majority does the patient *appear* to be a subject of terrific

pain. I recall a patient who sat for three weeks in a darkened room, carefully screened to prevent a fly lodging on the face, not venturing to speak, on a liquid diet taken through a glass tube inserted in the angle of the mouth on the unaffected side—a pathetic subject, living in mortal terror of a paroxysm. This was a case of exceptional severity. The great majority of patients continue without interruption of their daily tasks. When, as on one occasion, I was asked to see a patient who was content to lie abed in a comfortable private room for three weeks, with the daily solicitation of nurses and doctors, I questioned at once the diagnosis and my suspicions proved true, for, after an operation performed elsewhere, contrary to my advice, the patient complained more of the numbness than she had previously complained of the pain. Despite the paroxysmal pain, patients with major trigeminal neuralgia are ambulant patients and prefer the distraction of their daily activities to the monotony of the sick room.

So far as one can judge from the facial expression, in many cases the patient's estimation of the violence of his paroxysm tends to exaggeration. No doubt the accumulative experience breaks down his morale, exhausts his endurance and the pains, at first tolerated with a certain amount of composure, later seem unbearable. A patient when asked how severe his paroxysms were, said, "It is a thousand times worse than a jumping toothache," and yet so far as one could judge from observation, this seemed to be a gross exaggeration.

Is there any other disease in the category of human ailment where the diagnostician must rely wholly upon the patient's words, with evidence wholly subjective and not an objective sign? Is there any greater opportunity for malingering? You or I could so faithfully describe the symptoms as to satisfy the examiner that we were fit subjects for the major operation. What controvertible evidence could be discovered to expose the fraud?

After years of daily contacts and living with these patients, I have been forced to the conclusion that they are troubled in their souls as much by apprehension as by the actual exhibition of pain. This may appear to be an unwarranted statement, acknowledgedly difficult to support with proof, yet frequent questioning and conversations with the patients seem to substantiate this belief.

The classical description of major trigeminal neuralgia specifies total freedom from pain between the paroxysms. This is not altogether true. A number of patients record a sense of soreness in the painful zone in the intervals. It specifies that there are intervals of weeks or months between attacks. Exception must be taken to this too; as time goes on the paroxysms are of daily occurrence without interruption.

Of the etiology of trigeminal neuralgia we know as little today as we did twenty-five years ago. It is with some embarrassment that we must acknowledge, despite the wealth of opportunity for observation, no outstanding addition to any essential feature of the disease. Major trigeminal neuralgia is a disease of unknown etiology, spontaneous in origin and continuing uninterrupted throughout the patient's life unless arrested by well-recognized pro-

cedures. Not a single instance of spontaneous cessation has been recorded.

Its differentiation from other forms of neuralgias should be unerringly made. Its earmarks are so unmistakable that errors in diagnosis are now unwarranted. Should there be a vestige of doubt this may be removed by an intraneural injection of novocain or a weak solution of alcohol. The nearest approach to the clinical picture of true trigeminal neuralgia is that of tumors of the Gasserian ganglion. In the intensity of the pain, in its paroxysmal character, and anatomical distribution, there is a very striking similarity, but a careful examination will in time detect some objective disturbances of sensation, often first of the conjunctiva. One may be misled occasionally and chiefly because of the pain distribution of malignant growths, extracranial that
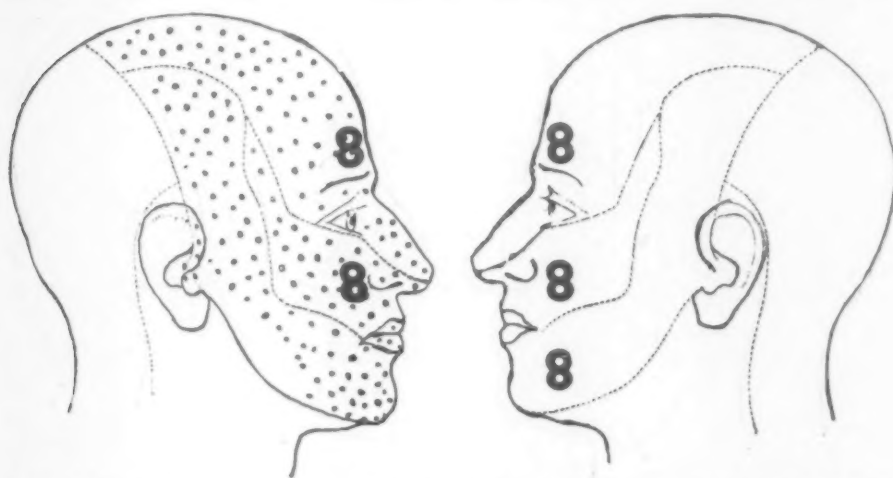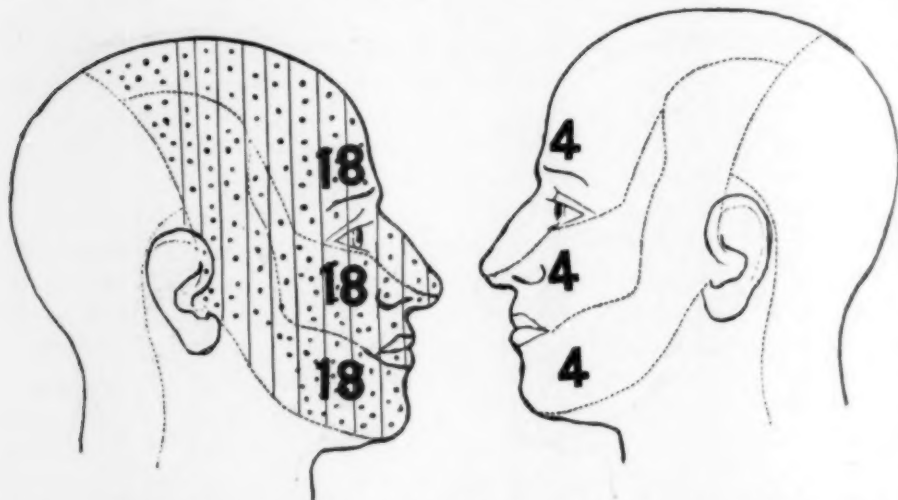

FIG. 1.—Record of pressure sensation following subtotal section of the sensory root. The dotted area indicates complete loss of sensation for touch, pain and temperature. The figures represent kilograms of pressure as registered by the algometer in a comparative test on the operated and unoperated side.

invade the second or third divisions at their exit from the skull. Obscure carcinomata of the maxillary antra may erode the posterior wall of the sinus and, still unrecognized and unsuspected, infiltrate the mandibular and maxillary divisions.

There is no excuse for confusing major trigeminal neuralgia with other pain pictures; with sphenopalatine neurosis, if there be such a clinical entity, with so-called glossopharyngeal neuralgia, an instance of which is not included in our 1214 cases, or with that medley of neuralgias which, for want of a better understanding, are called "atypical." These all are horses of a different color and should readily be recognized as such.

Physiological Problems.—It is acknowledged that the trigeminal nerve is a nerve of perception for pain, for touch and for temperature. From numerous observations made after section of the sensory root, we find no reason to qualify this statement in the slightest particular. That the trigeminal nerve supplies sense of taste to the anterior two-thirds of the tongue may be accepted without question. In an effort to find some explanation for the

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atypical neuralgias we have surveyed the entire afferent system—the trigeminus, the facialis, sympatheticus. (No attempt has been made to invade the field of the other cranial nerves.) When opportunity offered, tests for all forms of sensation have been made. (For these tests I am indebted to Dr. E. C. Russell.)

1. In paralysis of the trigeminus alone (Fig. 1).
2. In paralysis of the trigeminus plus facial paralysis (Fig. 2).
3. In paralysis of the trigeminus plus periarterial sympathectomy (common carotid artery. (Fig. 3.)
4. In paralysis of the facialis without trigeminal or sympathetic disturbance (Fig. 4).

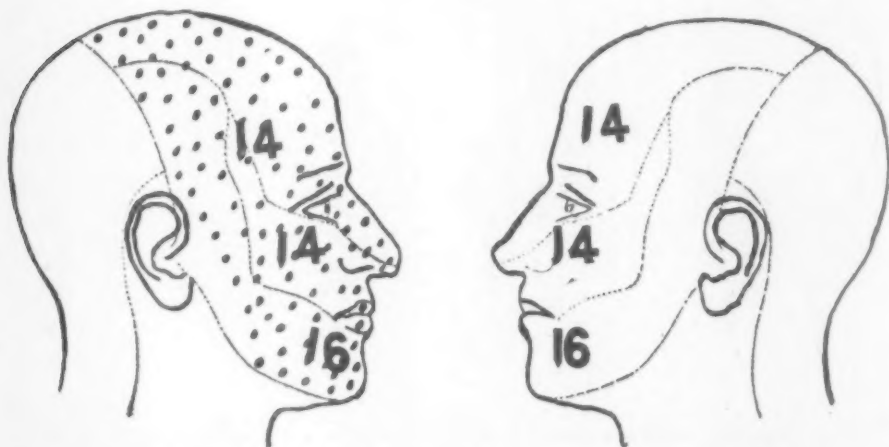As for the sympathetic system, we have no evidence that any form of sen-

Fig. 2.—Record of pressure sensation following subtotal section of the sensory root. The dotted area indicates complete loss of sensation for touch, pain and temperature. The lines indicate a complete paralysis of the peripheral type of the seventh nerve. Figures represent kilograms of pressure as registered by the algometer in a comparative test on the operated and unoperated side.

sation, that is the appreciation of pain, of touch or of temperature, is in any way influenced after excision of the superior ganglion with or without stripping of the periarterial plexus of the common carotid. That vague and varying pains have been experienced upon electric stimulation of the sympathetic we have recorded elsewhere. Similarly have we made note of the pains referred to within the trigeminal zone upon ligation of certain vessels, especially the superior thyroid artery. Anent the question of vascular origin of certain pain syndromes not of trigeminal origin observations have been made in the clinic as to the relation of vascular distribution to these pain zones. These observations proved futile.

To the facial nerve has been ascribed the perception of pressure sense (by Spiller, Ivy and Johnson, Davis, Gerard, Douques and Hartmann—*Arch. Neurol. and Pysch.*, 1928, vol. xix, No. 4, p. 699.) When opportunity offered, in cases with paralysis of both trigeminus and facialis, the perception of pressure and of pressure-pain has been recorded. These observations have been quite constant and are represented in the accompanying chart. (See Fig. 1.)

In this one sees recorded in terms of the pressure manometer the variations in degree.

Anatomical Data.—A study of the development of the sensory root and Gasserian ganglion in the fetus has been recorded. (*Brain,* Vol. XLVIII, Part 4, 1926.) This study gave us a conception of the structures of root and ganglion, not hitherto appreciated, and of great practical import in the interpretation of certain clinical aspects of trigeminal neuralgia. We found the sensory root composed of three separate and distinct bundles, one for each of the three portions of the ganglion, the ophthalmic, maxillary and mandibular. We found the motor root, as it passed behind the ganglion, received fibres from the ganglion. (Fig. 5.) We found that in the development of the ganglion the ophthalmic portion exhibits a certain isolation from the other two portions, as though nature intended some differentiation in

FIG. 3.—Record of pressure sensation following subtotal section of the sensory root. The dotted area represents complete loss of sensation for touch, pain and temperature. Note blockage of the sympathetic in addition to a complete sensory paralysis of the fifth does not alter relationship of pressure readings. Figures represent kilograms of pressure as registered by the algometer in comparative test on operated and unoperated side.

function, as in certain lower forms of animal life when there is an entirely separate and distinct ganglion for the ophthalmic distribution. We found a free intermingling of the fibres given off from the middle and outer portions of the ganglion to the maxillary and mandibular divisions. We saw in these embryological features an explanation for the more frequent association of pain in the maxillary and mandibular divisions, and the infrequent association of pain in the ophthalmic division with pain in the other two divisions. (Fig. 6.)

One might claim an intimate acquaintance with the gross anatomy of the middle fossa after 500 or more observations in as many operations. On a small scale the variations may not appear striking, but if the scale were amplified to any considerable degree, the variation in structure would be amazing. It would be a gross exaggeration to say that no two middle fossæ look

exactly alike and yet one never exposes a middle fossa without the feeling that in minute particulars it is different.

But speaking in more specific terms, there unquestionably are two gross patterns of the middle fossa, one common to the brachycephalic and one common to the dolichocephalic skull. (Fig. 7.) In the broad brachycephalic skull the plane of the middle fossa is horizontal and the angle of the petrous process of the temporal bone less acute. In the narrow and longer dolichocephalic skull there is a sharp pitch or declivity to the plane of the middle fossa and the petrous process describes a more acute angle. A clearer concept of the difference between these two extreme types, between which there are of course gradations, might be had were one to fashion a brachycephalic skull of a
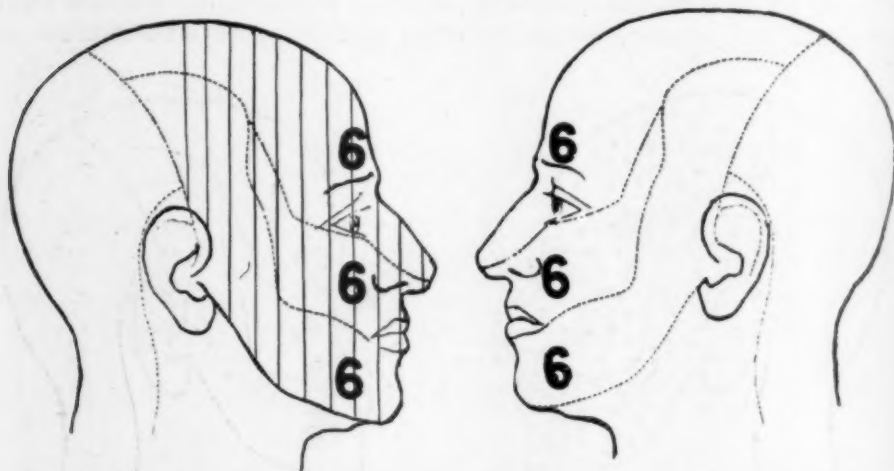
FIG. 4.—Record of pressure sensation in a complete paralysis of the seventh nerve. Figures represent kilograms of pressure as registered by the algometer in comparative test on the two sides.

plastic material. Lateral compression of the plastic structure would narrow the transverse diameter, increase the longitudinal diameter, increase the vertical diameter, thus deepening the floor and increasing the angle of the petrous bone. (See Fig. 8.) The practical significance of these differences in anatomical types is obvious. In the broad, flat skull the ganglion is more readily exposed and with less elevation of the temporal lobe, and the foramen ovale and the region of the ganglion is more nearly on a line almost at right angles to the zygoma from its midpoint. Whereas in the long narrow skull, with its deep fossa, with the petrous bone at a sharper angle, our objectives lie not only on a deeper plane, but have been moved further forward. At first glance of a patient with a broad skull, one's original impression might be that the sensory root would be more distant and therefore more difficult of exposure than with the narrow skull. As a matter of fact, it is the reverse. This, perhaps, is the most striking variation in the operative field, viewed as a whole. There are many minute variations of which the following may be cited as an example. External to the foramen ovale there is a bony eminence. This may vary from a dome like structure or a bony

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ridge, to the most minute spicule of bone. If very small it is disregarded. If larger it is removed with a chisel even though it may be only two, three or four millimetres in height.

An interesting observation was made by one of my staff (Gardner). It was discovered after operation, by accident, that one patient had had a hemorrhage in the middle ear. After this observation the auditory canal was examined routinely, and in several other cases the same complication occurred. In searching for an explanation, Gardner found there was a branch of the
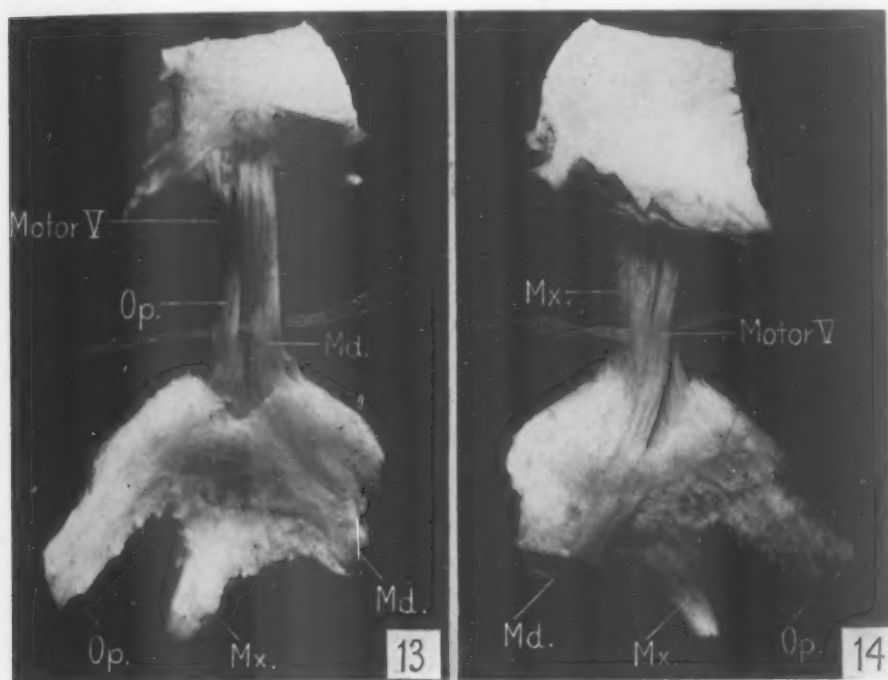
FIG. 5.—Ventral and dorsal views of a dissection of the left semilunar ganglion of a human fetus (No. 2519) 238 mm. crown-rump length, with an estimated age of twenty-eight weeks. The sensory root can be seen emerging from the hilum of the ganglion and the different portions of the root are indicated by a wisp of silk thread inserted between the maxillary, on the one hand, and the ophthalmic and mandibular, on the other. The surface of the ganglion, when looked at under the binocular microscope, can be seen to be covered with a sheet of fibres which are passing peripheralward to form the individual nerve trunks. The origin of the motor division can be seen in Fig. 13, and in Fig. 14 it can be seen to pick up processes from the maxillary portion of the ganglion on its way to join the mandibular nerve.

middle meningeal vein taking its origin in the middle ear and making its exit through the hiatus Fallopii. In separating the dura from the skull this branch is torn and the obstruction to the venous outlet evidently precipitates hemorrhage in the middle ear. Since this observation was made we have been able to identify the point at which this tiny vascular connection leaves the dura and penetrates the skull.

Of the possible sources of hemorrhage, anatomical works do not describe in detail or dignify with any special name, a venous channel in such close relationship with the ganglion that it is readily exposed to rupture. This venous channel as one sees it in this operation follows a course from a point adjacent

to the posterior margin of the ganglion arching over the ganglion. As the dura is elevated with retractor, it is almost in immediate contact with the maxillary division and when torn it is usually at this point. To secure perfect hæmostasis after the operation one should know just where a muscle graft should be placed to control hemorrhage of this origin.

The variation in the size of the ganglion is a commonplace observation. Sometimes the distance between the points at which the maxillary and mandibular divisions are given off to the sensory root is but a fraction of a centi-
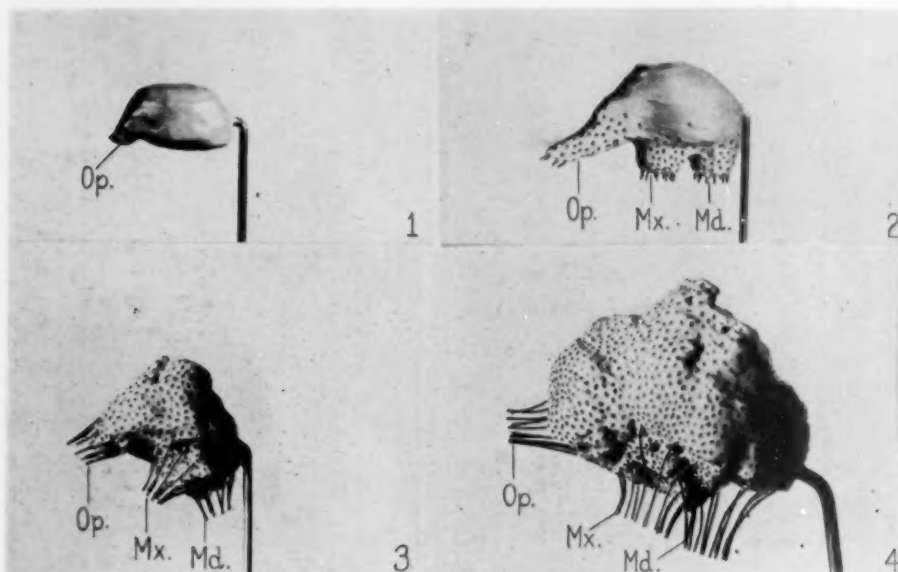
FIG. 6.—These illustrations were made from embryologic models of the semilunar ganglion from the human subject at various stages of development. One notices especially the precocity in the development of the ophthalmic divisions, its aloofness from the mandibular and maxillary divisions and the close association of the latter two.

metre. The longer the intracranial sections of these two divisions, the smaller it seems is the ganglion. Perhaps more a matter of pathological than anatomical interest is the difference in the constitution of the sensory root. To cite two extremes: in the one case a root with fasciculi and bundles easily separated one from the other; in the other a root in which the fasciculi seem to adhere snugly, so that not only is separation of the bundles not easy, but there is a snug adherence of the arachnoid to the root. These findings one can explain only on the assumption of a preëxisting inflammatory process. Not only in the structure of the root but in the adhesions one finds between dura and skull, and especially between dura and ganglion, one must postulate a preëxisting basilar meningitis. That this may play a part as an etiologic factor in some cases is a reasonable assumption.

Besides these variations in the structures of the sensory root, one finds variations in the structure of the motor root. Not only does the motor root vary in size, but instead of a single fasciculus as in the majority of cases there may be two distinct fasciculi. One should bear this in mind as one

might be tempted to divide one or the other of these in the thought that it might belong to the sensory root. But on careful inspection one can readily see that both fasciculi pass behind the ganglion.

The incidence of facial paralysis as a complication or sequel of the radical operation has long been a perplexing problem. About once in twenty-five operations this complication will follow the operation at varying periods. Never immediately after the operation, but usually at the end of the first twenty-four hours and before the lapse of forty-eight hours. In one instance
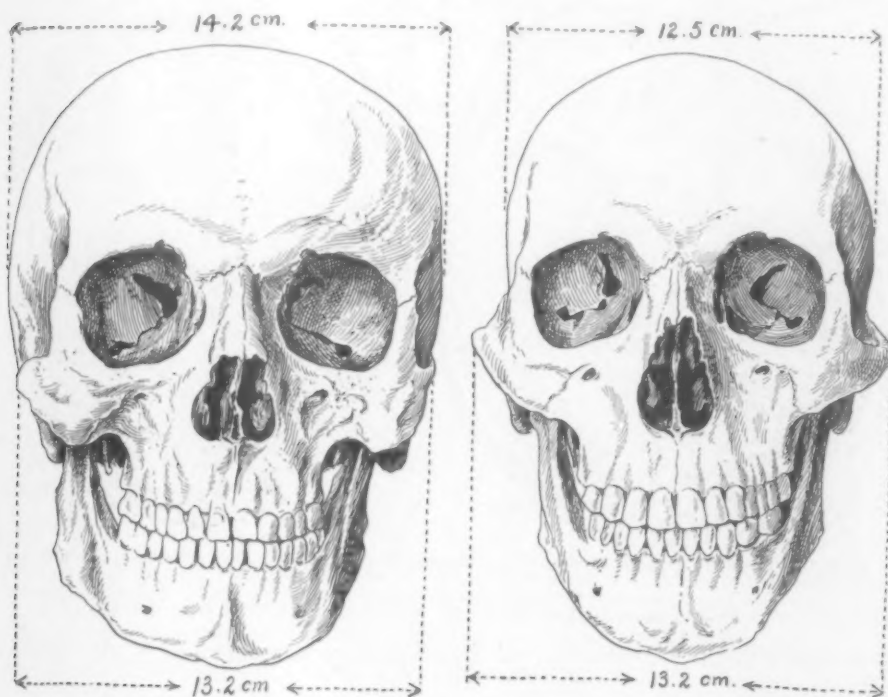
Fig. 7.—Brachycephalic skull. Dolichocephalic skull. These illustrations are drawn to scale from actual specimens and illustrate the fact that the bizygomatic diameters in the two skulls are exactly the same (13.2 cm.) although the biparietal diameter of the broad skull is 14.2 cm. while that of the narrow skull is 12.5 cm.

the paralysis did not develop until after the patient had been discharged. Obviously the lesion of the facial nerve must be of indirect origin, as the nerve is not within the operative field, either within or without the skull. In the days of the original Hartley-Krause operation, the anterior limb of the prescribed horseshoe incision might well sever the supply to the occipito-frontalis, and sometimes to the orbicularis palpebrarum, but the paralysis we are discussing involves the entire facial distribution and not only the upper branches. The only conceivable relation between the field of operation and the main trunk of the facial nerve is through the branch of the great superficial petrosal nerve. In its course this nerve lies nearest the operative procedure on the base of the skull posterior to the ganglion. It is protected by a process of the dura and it is my belief that when the base of the skull is

bared of this process the nerve is exposed to damage and possibly by traction or by hemorrhage within its sheath the parent trunk of the nervus facialis suffers. The tardiness with which the paralysis develops after the operation rather bespeaks hemorrhage as the cause. Certainly the paralysis could not be due to any damage to the nuclear centre. Fortunately the prognosis is always good. While it is a matter of some chagrin to the operator, the patient can be assured that the paralysis is only transitory. Recovery as a rule is
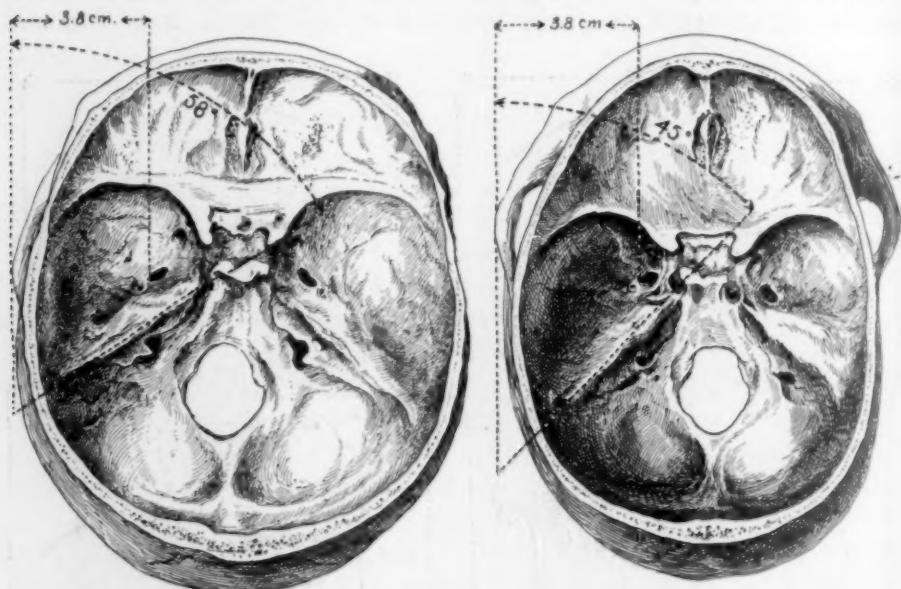
FIG. 8.—(A) B. achycephalic skull. (B) Dolichocephalic skull. These illustrations are also drawn to scale from the same specimens as depicted above and illustrate the more acute angle of the petrous bone in the narrow skull (45 degrees) as compared with 58 degrees in the broad skull. However, the distance from the outer surface of the zygoma to the foramen ovale is identical in the two skulls (3.8 cm.).

slow and complete restoration of function may not occur until six months have elapsed.

Operative Questions.—We have described the operative procedure in previous publications—the most recent in a contribution to *Surgery, Gynecology and Obstetrics* (now in press), therefore we shall not discuss the details here. We are convinced that our program of anæsthesia is the most acceptable. No doubt the operation can be performed under local or regional anæsthesia but in our experience the patient welcomes loss of consciousness. The patient has already suffered so much from the apprehension of pain that he or she dreads the thought of the ordeal of an operation if conscious of what is going on. So it is best to begin the operation under a general anæsthetic, ether preferred, which is not administered until one is ready to prepare the operative field and place the draperies. In a few minutes the patient is unconscious, the operation begun and as soon as the ganglion is reached, it is injected with 1 c.c. of 2 per cent. solution of novocain. The ether is then discontinued, and before the patient regains consciousness the operation is concluded. Thus the advantage of a general anæsthetic with a

minimum amount of ether. Speaking of injecting the ganglion, we have found it helpful should there be any oozing from the surface of the ganglion itself to inject into the ganglion, under pressure, normal saline solution. This has an immediate hæmostatic effect.

The approach to the ganglion may be made through a curved incision, which we have employed from the beginning, or through an oblique incision, but an important feature of either is a short horizontal limb parallel to and just above the zygoma. This gives width to the exposure where it is most needed, that is, at the base of the skull. We have continued to plug with cotton the foramen spinosum as the simplest way of controlling hemorrhage from the middle meningeal artery which with its accompanying vein must always be cut to give adequate access to the sensory root. The peripheral stumps of the vessels are clamped with silver clips at the conclusion of the operation.

The two essentials for an orderly, precise operation are proper illumination and control of bleeding. The former is provided by an illuminated retractor first employed in this clinic many years ago. The second essential is provided for with a suction apparatus which may be used not only for suction but, in approaching the ganglion, bluntly to separate dura from skull. More recently we have added to our armamentarium a septal elevator, which we use to separate the dura from the surface of the ganglion, that can be used also for suction. The combination is ideal and serves a most useful purpose when searching, as one must, for a line of cleavage between the dura mater and the dura propria, and when separating these two layers until the surface of the ganglion is exposed.

This operation was described in a popular text-book as "bloody, difficult and dangerous." Exception is well taken to the last qualifying term. Some operations are time-consuming and tedious rather than difficult, but none of the operations are "bloody", in the sense that there is massive bleeding. No doubt there were in the early operations on the ganglion when, judging from the literature of the day, the cavernous sinus was torn not infrequently. There is, of course, an extraordinary variation in the amount of troublesome oozing; in some cases almost none, in others constant oozing from many sources that may tax the operator's patience.

The essential features in the so-called radical operation for trigeminal neuralgia deals with the sensory root. To Spiller (Spiller and Keen, *Am. J. of Med. Sciences,* November, 1898), credit is given as the first to propose section of the sensory root as a substitute for resection of the Gasserian ganglion. Prior to that, resection of the ganglion was the conventional radical operation, with only a few years before (1894) a mortality rate of 22.5 per cent. In 1901, the first deliberate section of the sensory root was performed in this clinic. (*Philadelphia Medical Journal,* December 14, 1901 and October 25, 1902.) Since that time the operation has been modified in certain essential particulars, notably in conservation of the motor root (1919),

and in conservation of a portion of the sensory root (1915). The significance of both in the welfare of the patient is obvious. For the occasional case of bilateral neuralgia conservation of the motor root offers the only hope of relief. This was demonstrated in this clinic in 1926 in the first case in which the major operation was performed on both sides. (*J. A. M. A.*, November 20, 1926.)

Conservation of a portion of the sensory root was first considered a feasible proposition and put into practice in 1915, and ten years later (*Arch. Neurol. and Psychiat.*, March, 1925), a series of twenty-five cases was recorded in none of which throughout these ten years had there been a trophic keratitis. The tremendous advantage of this to the patient is apparent. When at a later period from our embryological studies we had a more accurate conception and more intimate knowledge of the structures of the sensory root and Gasserian ganglion, the principle of subtotal section of the root was extended to a wider field, so that today only that portion of the root is divided which conveys the afferent impulses from the pain area. We are quite firmly convinced that, if pain is controlled or arrested in the zone in which the paroxysm is initiated, this will be all-sufficient. In some cases, therefore, we have divided only that portion of the root which supplies the zone of the initial paroxysm. That is in a case where the pain originates invariably in the third division, but extends to the territory of the second division, we have divided only the outer third or mandibular portion of the root. But as a rule, especially in cases of long standing, we cut such portions of the root as correspond to the pain distribution. Usually it is the middle and outer portions, that is the mandibular and maxillary, but it may be maxillary and ophthalmic, mandibular and ophthalmic. Any combination is possible. No one may question the absolute justification of conserving the ophthalmic division of the root, but why bother to conserve the mandibular or maxillary divisions? Because it reduces the area of post-operative anæsthesia. While the true "tic" case is quite willing to exchange numbness for pain, this numbness will in some cases be a source of considerable annoyance and the more we can reduce the zone of anæsthesia, which in the first division includes an area as large as that of the other divisions combined, the better for the patient.

After the Operation.—In the twenty-five years covered by this survey, there has been a striking change in the minds of the doctors, as of the lay people. Twenty-five years ago doctors told their patients, at least many of them did, that the radical operation was a kill or cure method. It required not a little assurance to ease the patient's mind as to the freedom from risk compared with other operations. But the profession knows now, and the patients too, that the mortality is a negligible factor. I say patients because among the more intelligent often they have taken occasion to inform themselves of the nature of the operation, even to reading from the medical press. In the last 269 consecutive operations for major trigeminal neuralgia, the mortality in this clinic has been 0.37 per cent. We are not concerned now

with the operative risks, but we do take certain precautions. A patient with a high blood pressure may be kept at rest for a week or two until the blood pressure falls as it does ten, twenty or thirty points with the patient at rest. A patient ill-nourished, dehydrated, exhausted because of fear of eating and long suffering, will be given an alcoholic injection so that he may have a brief respite from pain and some attention paid to his nutrition and fluid intake. With a patient over eighty years of age we may advise against operation as the risk may be great and the expectation of life short.

Anent the question of high blood pressure, we were once inclined to believe that the agonizing pain of trigeminal neuralgia might be a factor in the hypertension. We were inclined to this belief because we had seen a number of instances in which a high blood pressure, 180–220 Hg. fell many points after the operation and continued at this level until discharge. Recently an inquiry has been made of the after history of this group, and where information is available we have found that in course of time the blood pressure has returned to its original pre-operative level.

But our chief concern is with the future of the patient. Before we learned the advantage of conserving the ophthalmic portion of the sensory root trophic keratitis was a troublesome complication. We know how often it developed before the patient left the hospital, but we made no great effort to ascertain what happened afterward. Happily, with the new technic, these days are over. As to the permanency of the cure there can be no question, providing all the essential portion of the root has been cut. In these 511 cases there have been two recurrences. In one of these we operated a second time and found one fasciculus of the second division that had escaped. So that there is an immense satisfaction to the surgeon and a corresponding gratification on the part of the patient in the permanent relief afforded. The story of the after effects of the operation would not be faithfully told were mention not made of the patient, now and then, who having been robbed of paroxysmal attacks finds himself or herself possessed of certain paræsthesias which sometimes become an obsession and are magnified to the last degree. One patient may fear these sensations may be the forerunner of a recurrence and when assured the paroxysms cannot recur he is content. Another is seemingly unable to accommodate himself to these paræsthetic sensations and complains bitterly. Fortunately he is the exception to the general rule. Some day we may have a clearer understanding of these paræsthesias and of the discomforts of the atypical neuralgias. A fundamental study of the afferent system of impulses now under way may shed some light upon these perplexing phenomena.

RECURRING ULCERS FOLLOWING PARTIAL GASTRECTOMY

By Donald C. Balfour, M.D.

of Rochester, Minn.

THE surgical treatment of peptic ulcer, in common with the surgical treatment of other chronic lesions, is not always followed by completely satisfactory results, nor are they necessarily permanent. In order to lessen the possibility of disappointing results, more radical surgical methods have been advocated, the most interesting of which has been partial gastrectomy. Although partial gastrectomy is usually the operation of choice for large perforated gastric ulcers, it does not appear to be a reasonable procedure for duodenal ulcers or for small gastric ulcers distant from the pylorus. In fact, removal of a large part of a normal stomach for the relief of a duodenal ulcer appears to be not only unnecessary but unwise.

In the earlier advocacy and performance of partial gastrectomy for duodenal ulcer the plea for such a radical procedure was based largely on physiologic grounds and little consideration was given to remote results. It is now clearly evident that partial gastrectomy for peptic ulcer, particularly duodenal ulcer, does not necessarily insure perfect digestion, nor does it necessarily protect the patient against subsequent ulceration. Several reports of recurring ulceration following partial gastrectomy have appeared, one of the most comprehensive being that of Birgfeld who classified fifty-three cases reviewed in the literature. This report is based on cases which have been seen in the Mayo Clinic.

All cases of recurring ulcer following partial gastrectomy were divided into three groups: (1) twenty-eight cases in which the ulcer was found at operation; (2) twenty cases in which a clinical or röntgenologic diagnosis (or both) of recurring ulcer was made, but chiefly because of mild symptoms the patients did not come to operation, and (3) five cases in which the subsequent course of the patient was either positive or very suggestive of recurring ulceration. The second and third groups are not considered in this report. (Table I.)

Of the twenty-eight cases in which operation was performed, fourteen followed resection for gastric ulcer, eight for persisting or reactivated duodenal ulcer following other operations, and six for gastrojejunal ulceration. Classifying these cases according to operation, three followed resection of the Billroth I type, six followed resection of the Billroth II type, ten followed sleeve resection, seven followed a Polya operation of the posterior end-to-side type, and two followed resection completed as an anterior end-to-side gastrojejunostomy (Tables II and III).

The cause of these recurrences cannot be established, since recurrence may take place when every known factor has been eliminated. The more important of these factors are: (1) hyperacidity, (2) operative trauma and technical

errors, such as injudicious use of clamps, poor approximation of suture lines, and inadequate drainage, (3) gross indiscretions following operations, for example, excessive smoking, ingestion of indigestible foods, prolonged nervous tension, and marked irregularity in meals, and (4) foci of infection. Furthermore, the cause of recurring ulcer in the individual case is just as difficult to establish as the cause of the primary ulcer. The most conspicuous group is that composed of the so-called ulcer-bearing patients who are often energetic, driving persons who cannot adjust their mental and physical activities to the capacity of their nervous system.

TABLE I.

Recurrence of Ulceration Following Partial Gastrectomy.

Recurrence of ulceration	Cases
Found at operation at the Clinic	28
Diagnosed at the Clinic	20
Diagnosed or operated on elsewhere	5
Total	53

The symptoms of recurring ulcer parallel those of primary ulcer in one important respect: the pain, regardless of situation, radiation, or severity, is related to the ingestion of food. A full diet usually aggravates the pain, while bland food eaten frequently at least partially controls it. This effect of food is a fundamental point in the clinical diagnosis of recurring ulcer.

Pain may vary greatly in situation, radiation and intensity. It is usually diffuse and more to the left, and often radiates into the lower part of the abdomen, particularly to the left side. If it is relieved by normal bowel movement or by enema, involvement of the colon by an inflammatory process or by the ulcer itself is indicated. Pain radiating to the left shoulder in recurring ulcer is almost pathognomonic of perforation against the diaphragm. I have seen several cases with this complication. The pain may be so severe as to require opiates for control and if there is diaphragmatic involvement may simulate and be mistaken for primary diaphragmatic pleurisy. Loss of weight, anemia, and dehydration are commonly associated by reason of the inadequate amount of nourishment.

In this series of cases the chief complications of recurring ulcer following partial gastrectomy were perforation, hemorrhage, and obstruction. Perforation is frequently acute but is usually protected by the colon, omentum, diaphragm, spleen, pancreas, a loop of small intestine, or the abdominal wall. I have met with examples of all of these types. Usually, however, the perforation is subacute and the inflammatory process may be very extensive. The colon is commonly involved; in one case a large fistulous tract had opened into the colon giving the characteristic clinical and röntgenologic signs of gastrojejunocolic fistula. The diaphragm may form the base of the ulcer. The inflammatory process may be so extensive as to form a palpable mass.

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Hemorrhage is not uncommon, and may be either gross or microscopic, with varying degrees of secondary anemia. Obstruction is rarely marked, particularly if the Polya type of resection has been performed.

Fluoroscopic examination in these cases is of great aid in establishing the diagnosis. A röntgenologist skilled in interpreting the mechanics of the stomach and the gastro-intestinal anastomosis after various types of resection can, in a high percentage of cases, report with accuracy as to whether or not a lesion is present. In 55 per cent. of these cases examination showed the free hydrochloric acid to be below normal, and in 26 per cent. there was an absence of free hydrochloric acid.

The treatment of recurring ulcer following partial gastrectomy is usually surgical. Occasionally symptoms may be sufficiently controlled by less radical treatment, but more often they cannot be controlled and operation becomes necessary.

Pre-operative observation and preparation of patients is exceedingly important. The difficulties and risks of operation are definitely lessened by rest in bed, a bland diet, and the administration of large quantities of fluid.

TABLE II.

Types of Lesion for Which Secondary Resection was Performed.

Recurrence following partial gastrectomy for	Cases
Gastric ulcer	14
Duodenal ulcer	8
Gastrojejunal ulcer	6
Total	28

TABLE III.

Types of Resection Followed by Recurrence of Ulceration.

Procedure	Cases
Billroth I	3
Billroth II	6
Sleeve resection	10
Resection with posterior end-to-side gastrojejunostomy	7
Resection with anterior end-to-side gastrojejunostomy	2
Total	28

In the surgical treatment certain general principles should be observed. It is unwise to attempt a plastic operation, that is, removal of the ulcer and reconstruction of the anastomosis. It is also unwise to employ the same segment of jejunum that was used after the primary resection, so this segment is either resected or, if in good condition after the ulcer is excised, closed and a segment distal to the closure selected for the new anastomosis. The operation should be done either without clamps or with clamps so lightly

applied that trauma will not result. All areas of obvious inflammatory change in either stomach or jejunum should be removed. The new anastomosis should hang free of the mesocolon and, if possible, a new type of gastro-intestinal anastomosis should be made. Finally, in the more intractable cases jejunostomy should be performed on the distal loop for the administration of nourishment and fluids during the first few days following operation. This not only is a factor of safety so far as the risk of operation is concerned, but it affords complete rest for the stomach and gastro-enteric anastomosis.

The selection of the best type of operation is governed by the type of the primary resection, the site of the ulcer, the extent of the inflammatory process, the involvement of other structures, and the condition of the patient. For recurrences following a Billroth I type of resection, posterior gastro-enteros-tomy should have first consideration since it may bring about complete relief. If this seems inadvisable, a reasonable amount of the stomach should be removed, that is, as far as the incisura, with closure of the duodenal stump and the reëstablishment of gastro-intestinal continuity by a Polya operation or one of its modifications. For recurrences following segmental resections, a Polya operation, or a modification, is advisable. For recurrences following a Billroth II or a posterior Polya operation, the anastomosis is first mobilized, the mesocolon dissected free, the site of the ulcer identified and a segment of the stomach, the entire anastomosis, and enough of the jejunum to remove all obviously inflamed tissue, are resected. The jejunal defect is then repaired by end-to-end closure, and a new anastomosis made from the end of the stomach to the side of the jejunum distal to the closure of the latter. The mesocolon is then sutured to the stomach well above the anastomosis. In three cases, recently, in which the jejunal loop was resected I made a Roux type of anastomosis: in one case I closed the end of the distal jejunal loop, doing an end-to-side (stomach to jejunum) anastomosis, then implanting the end of the short proximal portion of the jejunum into the distal loop about 5 cm. below the gastro-enteric union; in the two others I closed about two-thirds of the end of the stomach, implanted the end of the distal portion of the jejunum into the remaining opening, and anastomosed the end of the proximal jejunal loop into the side of the distal portion of the jejunum below the gastro-enteric anastomosis. In all of these a jejunostomy tube was used. The patients have been completely relieved of symptoms; free hydrochloric acid has been absent on repeated examination, and the stomach apparently was functioning normally. Such a method at least has the advantage that any ulceration that may occur in the future is more easily dealt with than if the entire end of the stomach is used.

Should ulceration recur in these cases further tissue may be resected and a new end-to-side anastomosis made. The anterior end-to-side anastomosis, although seldom employed for ulcer, has the advantage that it is much more easily dealt with than a posterior anastomosis in case a secondary operation is necessary.

The site of the ulcer determines, to some extent, the type of the operation.

Ulcers entirely in the jejunum, if on the mesenteric side or in the distal loop, are either excised or the segment of jejunum is resected. If the ulcer is in the proximal loop of the jejunum and almost inaccessible because of a short loop, there is at least a fair chance that the lesion will heal if the new anastomosis is made 7 or 8 cm. distal to it. In some cases the ulcer is so awkwardly situated and the inflammatory process so extensive and so acute that temporary jejunostomy to permit the inflammation to subside is an excellent procedure. In a case in which I recently employed this method the patient has been completely relieved of pain and it appears that the ulcer has healed. Such a possibility should always be kept in mind in recurring ulceration, just as in primary ulceration.

Involvement of the colon in the inflammatory process should be dealt with after the entire anastomosis has been mobilized. After the colon has been dissected free, it is frequently found that its wall forms the base of the ulcer. This base is curetted, iodized and plugged with surrounding omental tags. If a fistula is present the fistulous opening is closed with chromic catgut, reinforced with silk, extra precautions being taken in wrapping the area with omentum.

If perforation against the diaphragm has occurred, the attachment is separated and the area on the diaphragm sterilized with iodine.

Finally, the condition of the patient is a factor in determining the type of operation, but anything but a radical operation is seldom necessary or advisable. The best alternative to such a procedure is jejunostomy.

The results of operation in these cases of recurrent ulcer after partial gastrectomy show the presence of a very intractable disease. As McVicar says: "There are outlaws in a surgical sense, just as there are outlaws in a social sense." Again it should be emphasized that partial gastrectomy as a primary operation for benign peptic ulcers does not afford absolute assurance that ulceration will not recur, and if such recurrence does take place, the difficulties of any further surgical procedures are often exceedingly great and the results none too satisfactory.

DISCUSSION: DR. ARTHUR D. BEVAN, of Chicago, Ill., said that in the last ten years surgeons have been led to believe by the work of Haberer and Finsterer and other German surgeons, and by Moynihan, in England, that in handling peptic ulcer a solution had been found very much better than gastro-enterostomy, and that is by actually resecting the ulcer, removing it. And they have led us to believe that recurrence of ulcer after stomach resection was extremely rare. Now, when Doctor Balfour reports that some fifty-three cases have been studied, found either in their own clinic, or in cases coming to the Mayo Clinic, from other surgeons, in which recurrence of ulcer after resections has been found, it puts a very different light upon the whole subject. It shows at once that even resection is not always a permanent cure of peptic ulcer.

He personally had never felt that it was. He had always felt that peptic ulcer was due to the action of certain very definite causes which might per-

sist after the occurrence of a first ulcer and its complete removal and result in the production of a new ulcer or ulcers.

From the time of Cruveilhier and Rokitansky we have had the conception that peptic ulcer, as its name implies, is due to the corrosive action of the gastric juice upon a damaged piece of stomach wall. He had been glad to find that in the elaborate work of Hauser which is published in the Henke-Lubarsch system of pathologic anatomy and histology, Hauser takes quite definitely that same simple position.

Now, of course, even after a resection we may have conditions in the stomach in which an ulcer may recur from the digestion of a piece of damaged wall, damaged usually from some vessel lesion. It is true that after a resection, especially a resection which has removed the magenstrasse, we have removed the most vulnerable part of the stomach. If we resect largely the lesser curvature extending from the œsophagus to the pylorus, we certainly have removed the most vulnerable part of the stomach, and we are not as apt to have recurrence if that part is removed. But that recurrences do occur is absolutely true. That fact is a very important thing in evaluating this whole large problem, to decide the question as to whether we should handle a case medically or surgically, to recognize the fact that a resection, no matter how wide, is not always a permanent cure.

One of our German colleagues made this statement in regard to a case in which repeated resections of the stomach had been made; four, I think, in number. He said, "Yes, if you have an ulcer of the leg, if you amputate the entire limb, you will have no further ulcers on that leg."

Dr. Herbert Alexander Bruce, of Toronto, Canada, said that two years ago he attended the meeting of the British Medical Association when Finsterer gave a paper on gastrectomy for peptic ulcer, in which he advocated in all cases the removal of the stomach for this condition. He reported one case just as Doctor Balfour has to-day, in which recurrence had followed gastrectomy, necessitating three subsequent operations. In other words, although he had removed a large portion of the stomach for peptic ulcer, recurrence of the ulceration had followed this operation and two subsequent operations.

Mr. Patterson preferred the operation of gastro-enterostomy for the relief of peptic ulcer, and the majority of the surgeons who were there agreed that as it is the simpler and safer operation, and has been attended by such excellent results that it should be the operation of choice. There are a few cases undoubtedly in which a gastrectomy is desirable and indeed necessary to effect a cure, but the pendulum is swinging too far in the direction of gastrectomy for the relief of all peptic ulcers, and therefore this paper of Doctor Balfour's to-day is welcome as showing that even gastrectomy does not necessarily cure all peptic ulcers.

CANCER OF THE STOMACH IN PATIENTS OVER SEVENTY YEARS OF AGE

By J. Shelton Horsley, M.D.

of Richmond, Va.

THE frontiers of old age are being pushed forward. With the prolongation of life the outer limits of middle age extend and old age is now putting in its appearance later and later.
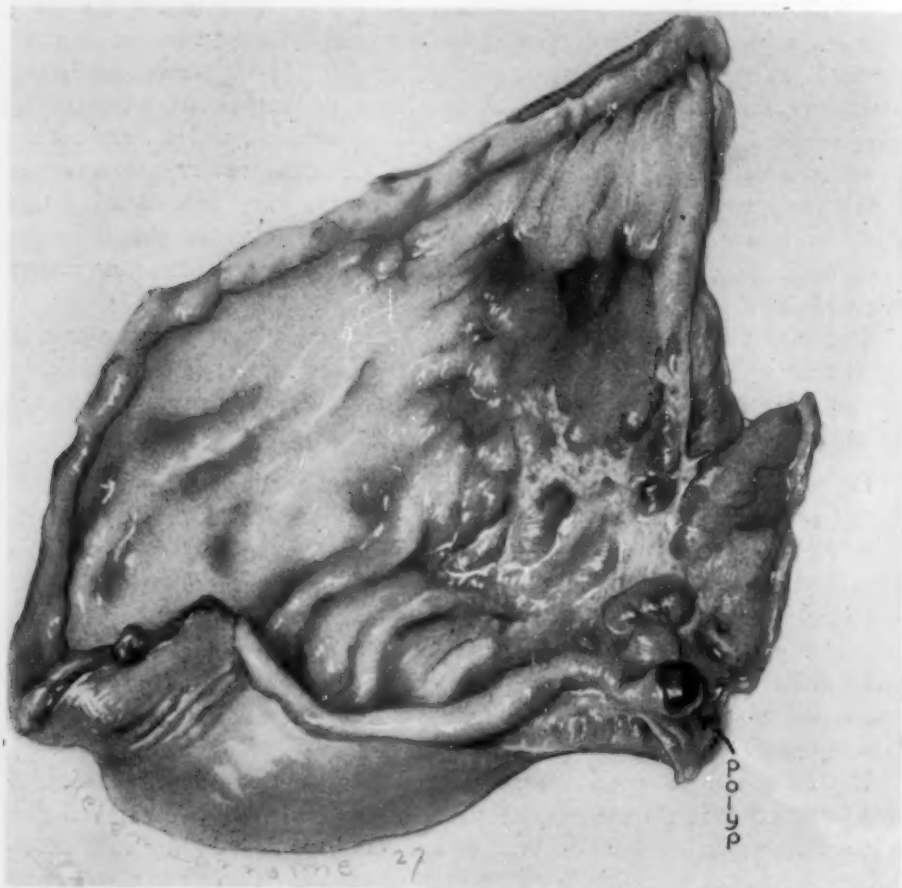

FIG. 1.—Anterior view of specimen consisting of the right portion of the stomach of patient, Mr. J. J. H., seventy-seven years of age. On the right is the duodenum. There is one soft polyp and another smaller one within the grasp of the pyloric sphincter. In the mucosa adjoining is a superficial moth-eaten type of ulcer. It is soft, apparently hardly penetrating to the muscular coat. Both the polyp and the ulcer proved to be a highly malignant type of cancer. (Case III.)

Probably we can agree, however, that a patient is beginning to get old at seventy, and at this age certain changes usually have occurred. No machine or organism can work for seventy years without some traces of wear and tear that necessarily affect to some extent the functional processes.

In treating diseases in the old often principles of treatment that are applicable in younger patients must be modified. For example, general anæsthesia that may be well borne in vigorous youth or in middle age may not be tolerated in a patient over seventy. Even the production of unconsciousness in the aged without any operation, particularly if for a prolonged time, is sometimes followed by cerebral disturbances or by an upset of the stomach, the kidneys or the lungs. Narcotic drugs are more dangerous in the old.

One of the well-known lesions that appears more frequently with increasing age is cancer, and the most important structure concerned with the metastasis of cancer is the lymphatic system. In the old the function of this system diminishes. The lymph-nodes rarely become enlarged unless from some marked stimulus, and the lymph vessels transmit but feebly. This tends to retard the metastases of cancer and gives more hope of cure from a radical operation in the aged than in those with a more vigorous lymphatic system.

No one is immortal; relief or cure is relative. An operation that saves a patient from the fatal effects of a gangrenous appendix at twenty and permits him to die of apoplexy at seventy merely prolongs his life for fifty years. It would seem, then, that if there is a reasonable chance of marked relief for a period

FIG. 2.—View of pyloric end of the stomach before the specimen was opened, showing the polyp protruding through the pyloric sphincter.

of at least a few months with even a slight prospect of cure, the fact that the patient happens to be over seventy should not be a contra-indication to operation.

During the past two and a half years I have done a partial gastrectomy for cancer on five patients over seventy years of age. While the technic of this operation was not altered from that which I have used for four years, and which has been published in detail elsewhere,[1] it seems to be particularly applicable in these cases. It is a modification of the Billroth I operation. With the natural relaxation of the tissues in these patients there is no difficulty in approximating the stump of the stomach to the duodenum. In the Polya operation the jejunum must be brought either over or under the transverse colon, so this additional field of manipulation is avoided. The operation consists in the union of the upper end of the stump of the stomach to the stump of the duodenum, flared open by making an incision into its anterior wall for about one and a quarter inches after the first row of sutures has been placed between the stump of the stomach and the stump of the duodenum, to fix the physiologic position of the lesser curvature. The researches of Alvarez, Klein, and others have shown the importance of the lesser curvature. It contains neuro-muscular structure, which initiates peristalsis, and the main centre for this is near the œsophagus. Klein thinks
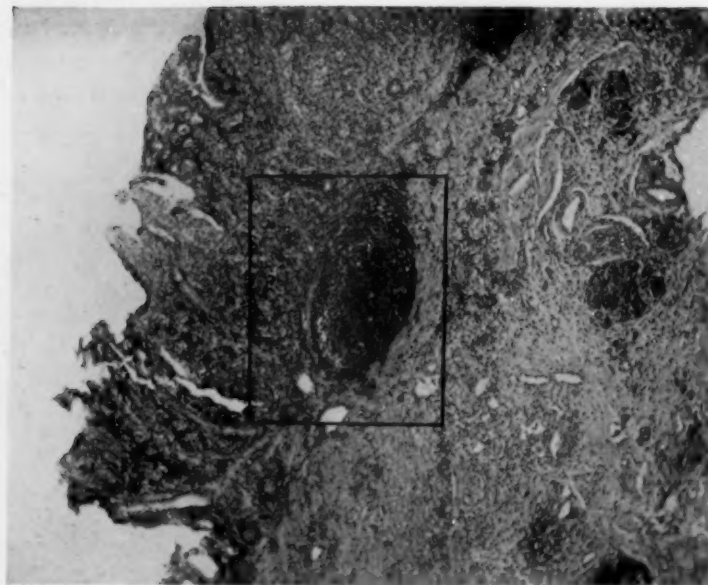
Fig. 4.—Section from the margin of the superficial ulcer in the gastric mucosa shown in Fig. 1. Showing leukocytic infiltration of the deeper tissues and carcinomatous change throughout most of the mucosa. In the centre is a lymph follicle around which there is moderate infiltration. ($\times$ 50.)
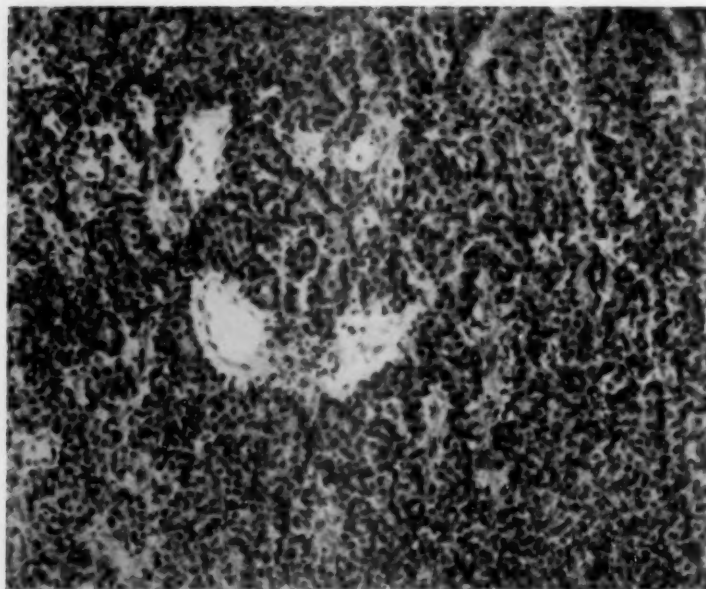

Fig. 3.—Case of Mr. J. J. H. Photomicrograph of polyp of the stomach seen in two preceding figures. In some regions there is an attempt at acinous formation, but in most of the field the cells are markedly undifferentiated. It is classed as a carcinoma, grade 4. ($\times$ 150.)

there is a secondary centre near the incisura. The incision in the duodenum prevents constriction which sometimes occurs if the thick wall of the stomach is sutured to the end of the thin wall of the duodenum. After this partial gastrectomy the gastric contents enter the duodenum and can be immediately subjected to the action of its circular fibres, so normal peristalsis may begin at once. By flaring open the duodenum an end-to-end union can sometimes be made; but if not, a purse-string suture easily turns in the redundant tissue at the lower end of the stump of the stomach, and this is reinforced by bringing over the adjacent peritoneal covered fat.

This operation, then, admits of wide excision of the cancerous area, of ample approximation of the stump of the duodenum to the stump of the stomach, and at the same time limits the field of procedure to the region of the excised portion of the stomach.

FIG. 5.—Higher magnification of a portion of the previous photomicrograph. Just above the lymph follicle is the carcinomatous mucosa. ($\times$ 150.)

The anæsthesia has already been mentioned. Local anæsthesia was used in the five cases here reported. The method consists in infiltrating the site of the proposed abdominal incision and to some extent blocking off the region of the incision by inserting the novocain solution several inches from it. After the abdomen is opened and the cavity is gently explored the anæsthetic solution is introduced in the retroperitoneal tissues above the head and body of the pancreas, and then to the left toward the body of the vertebræ above the pancreas. Other retroperitoneal tissues, as along the root of the transverse mesocolon, are infiltrated, and if the patient complains of pain on traction, infiltration of the tissues as high up on the left side along the vertebral column as possible and in the retroperitoneal tissues above the head of the pancreas is again done. The anæsthetic used is 0.5 per cent. novocain in which about three drops of adrenalin solution is added to every ounce of the mixture. This is made in freshly distilled water to which tablets have been added to make it a standard Ringer's solution.

CASE I.—Mr. C. L. W., white, retired druggist, seventy-one years of age, admitted to hospital, December 27, 1925. He was much emaciated. For two or three months before admission to the hospital there was a dull pain in the upper abdomen, coming on after eating. The pain was intermittent in character with slight nausea and occasional vomiting. There was considerable abdominal distention. There had been no
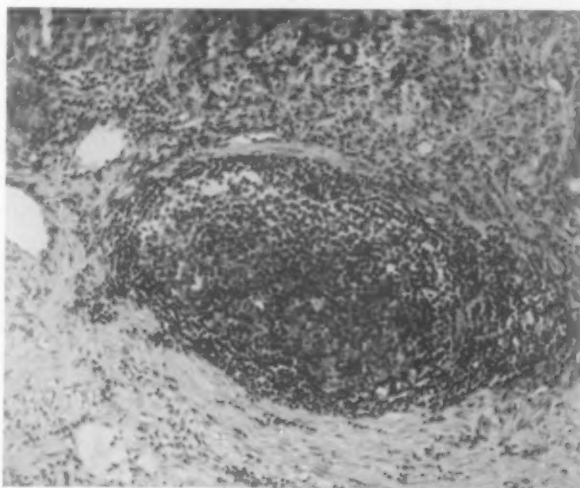
hæmatemesis or blood by bowel. Operation, December 29, 1925. In all of these five cases the partial gastrectomy that has been described was done. The stomach was somewhat distended, though it had been washed out about an hour before the operation. On removing the Payr clamp on the stomach it was found that the stump of the stomach was filled with semisolid and solid material which could not pass through the stomach tube. It was necessary to scoop out this with the hand. After cleaning the stomach as thoroughly as possible the clamp on the duodenum was removed and the operation was completed in the usual way. The operation lasted two hours and fifteen minutes. The pulse was 72 at the beginning of the operation, and 80 at the end.

The specimen, consisting of the pyloric end of the stomach, measured along the greater curvature 23.5 cm., and along the lesser curvature 11.5 cm. There was an infiltrating growth in the anterior wall of the stomach adjoining the pylorus and along the lesser and greater borders of the stomach there were a few enlarged firm lymph-nodes. Internally there was an ulcer with raised everted margins and the stomach wall was thickened, producing almost complete obstruction. Microscopic examination showed adenocarcinoma of moderate malignancy.

The patient made a very smooth recovery, there being merely a superficial infection in the skin wound. The pulse rate never exceeded 100, nor the temperature 99.8. He was discharged on January 29, 1926, with a temperature of 98.4, pulse 76.

FIG. 6.—Section from the cardiac margin of the specimen showing the mucosa practically normal, without carcinomatous change but with moderate leukocytic infiltration. ($\times$ 75.)

He gained in weight and was in good health until in October, 1926, when he complained somewhat of occasional attacks of dizziness. This apparently did not annoy him seriously, but early in 1927 he began having some gastric symptoms. On May 24, 1927, examination showed a rather firm mass beneath the abdominal scar. The mass was slightly movable and seemed to be attached to the stump of the stomach. The liver was not enlarged. The patient's general condition was fairly good. In view of these things and of the fact that histologically the tumor was not very malignant, even though it was rather extensive, further operation was advised but was declined. The patient gradually grew worse, and died October 29, 1927, nearly two years from the date of operation.

CASE II.—Mr. B. C. M., farmer, white, admitted to the hospital, May 24, 1926, complaining of "stomach trouble." For the last fifty years he had been subject to "indigestion," and was relieved only by an ulcer diet. He was emaciated, and had lost about fifteen pounds in weight in the past six months. For seven months he had had epigastric pain with nausea. The pain was constant, with no definite relation to meals. The nausea increased after taking food. Röntgenologic examination showed a large filling

defect in the pylorus. A partial gastrectomy was done May 28, 1926. The operation lasted two hours and thirty minutes. His pulse was 90 at the beginning of the operation, and 70 at the end.

The specimen consisted of the pyloric end of the stomach measuring 17.5 cm. along the greater curvature and 11.5 cm. along the lesser curvature. Along the greater and lesser curvatures were enlarged lymph-nodes. On the lesser curvature they extended
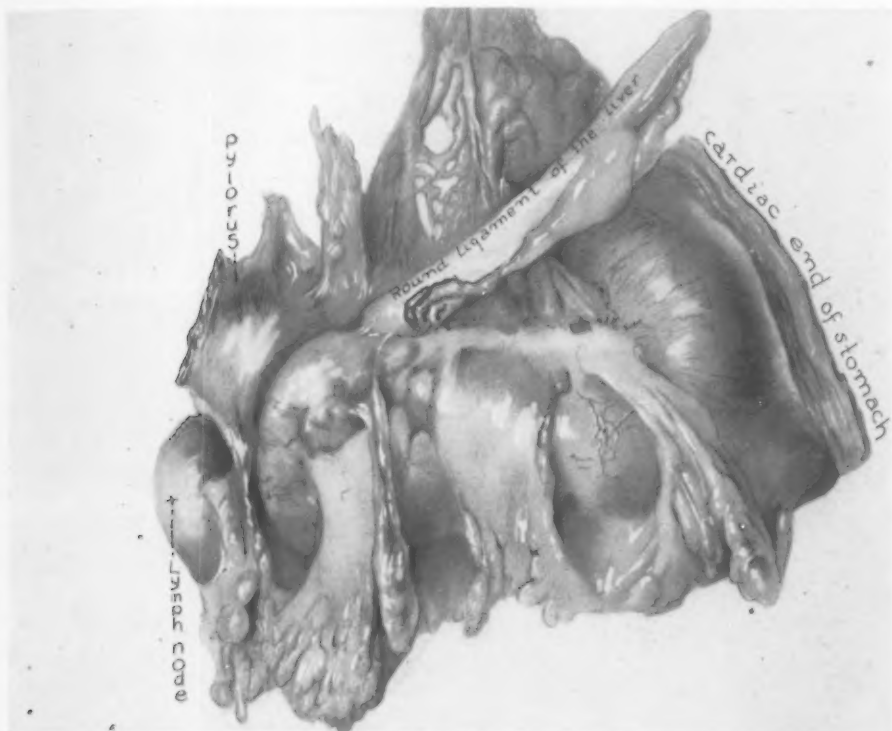

FIG. 7.—The anterior view of the right half of the stomach removed from Mr. F. C., seventy years of age. The growth infiltrated the entire wall and involved the round ligament of the liver. There are several large lymph-nodes along the greater curvature. (Case IV.)

almost to the end of the specimen. Most of them were firm and appeared to be metastases. There was an excavating ulcer with everted margins. The sections showed adenocarcinoma of considerable malignancy, about grade 3.

The patient developed pneumonia and on this account had a somewhat stormy convalescence though the operative wound healed well. He left the hospital June 22, 1926, in good condition, with a pulse of 60 and temperature 98.

He improved and was in good health until early in November, 1926, when he had pain in the epigastrium. Food seemed to accentuate the pain and caused a slight nausea. Röntgenologic examination at this time showed that the stomach was apparently functioning normally except for rather rapid emptying. No evidence of recurrence of the cancer in the stomach was found. Physical examination showed distended veins over the upper abdomen and some tenderness over the liver region. No definite masses could be felt. The patient died March 21, 1927. There was a history of increasing discomfort in the upper abdomen with probably enlargement of the liver. There was no necropsy, but death seemed to be due to metastasis in the liver.

CASE III.—Mr. J. J. H., white, age seventy-seven, farmer, entered the hospital, February 8, 1927, complaining of indigestion, nausea and vomiting. He was markedly emaciated and had lost about forty pounds in weight in the past two years. About

two years before admission he had suffered periodic attacks in which food seemed to "sour on the stomach." These symptoms were relieved by vomiting. He had vomited no blood, and none was passed by the bowel. He was sometimes free from symptoms. Röntgenologic examination showed almost complete obstruction at the pylorus.

A partial gastrectomy was done February 10, 1927. The stomach was markedly dilated, but the peritoneal covered surface seemed normal. There was an indefinite
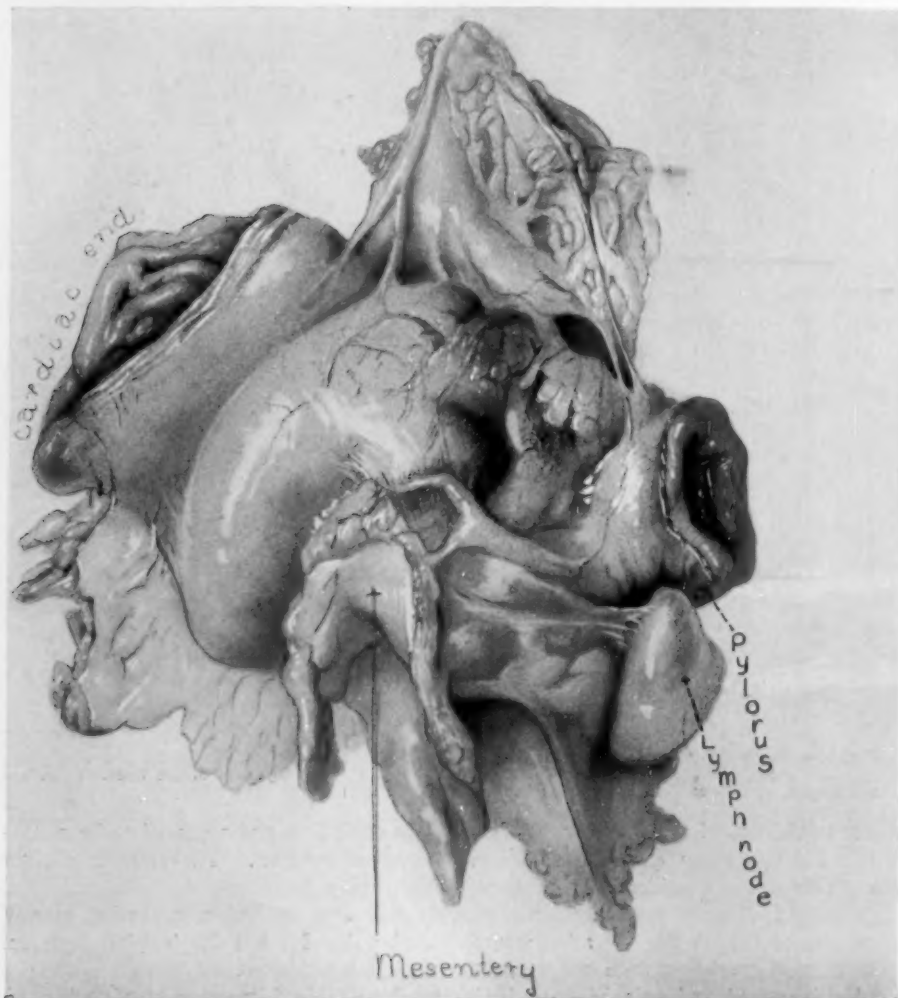

FIG. 8.—Posterior view of the specimen shown in the preceding figure. Note the attached mesocolon which was adherent to the cancerous mass and was resected with it.

soft mass about the pylorus, but there was no induration. The lymph-nodes were apparently not involved. The stomach was greatly distended. There was a quantity of solid material in the stomach, and as in Case I it was scooped out with the hand. The operation lasted two hours. The pulse was 60 at the beginning of the operation, and 66 at the end.

The specimen, consisting of the pyloric portion of the stomach, measured 12.5 cm. along the greater curvature and 8 cm. along the lesser curvature. Externally the peritoneum seemed smooth and presented no evidence of infiltration. On the mucous

surface there were superficial ulcerations in the pyloric mucosa. (Fig. 1.) Projecting into the pyloric sphincter from the stomach was a small polyp-like growth. (Fig. 2.) There was evidence of marked gastritis. There was a small mass in the gastro-hepatic omentum along the lesser curvature which on incision contained thick yellowish fatty material with no evidence of malignancy. The ulceration in the pyloric mucosa was irregular in contour, and apparently did not extend through the whole depth of the
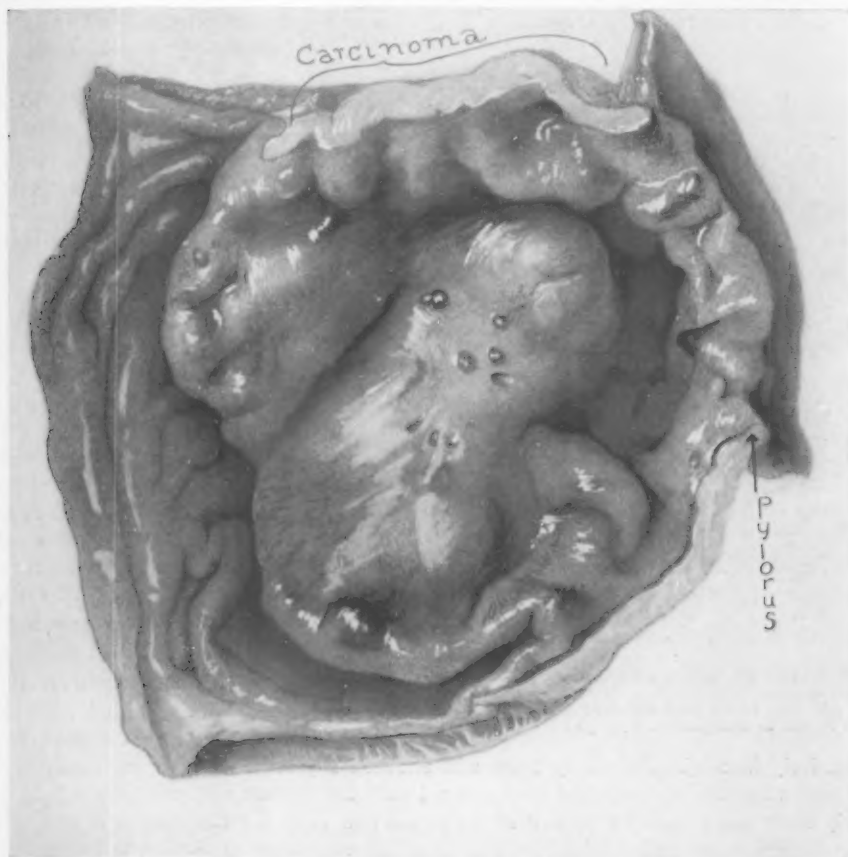

Fig. 9.—The interior of specimen shown in the preceding two figures. There was a large ulcerating carcinomatous mass with sharply marked margins which were firm.

mucosa. Sections both from the polyp and from the margin of the ulcerated area showed carcinoma of a high degree of malignancy. A specimen submitted to A. C. Broders, of the Mayo Clinic, was graded by him as 4. (Figs. 3, 4, 5 and 6.)

The patient made a smooth operative recovery, his pulse never exceeding 96. He was discharged on March 4, 1927, in excellent condition, with pulse 80 and temperature about 98.

He was greatly relieved by the operation, and for several months his health was excellent. He developed nephritis, however, and died October 26, 1927, of nephritis. There was no necropsy, but there was no clinical evidence of a recurrence of the cancer.

CASE IV.—Mr. F. C., white, age seventy, farmer, was admitted to the hospital on March 31, 1927, complaining of a "lump in the stomach." He was emaciated, and had lost twenty pounds in weight in the past three months. The present illness began about three months before admission with loss of appetite and weakness. Pain developed about

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three weeks before admission. There was no nausea or vomiting, and the patient had apparently passed no blood by bowel. Röntgenologic examination showed a large filling defect in the pyloric portion of the stomach.

April 5, 1927, a partial gastrectomy was done. The growth was quite extensive. It had invaded the round ligament of the liver anteriorly and some of the mesocolon posteriorly. There were a few enlarged lymph-nodes on the greater curvature, but none appeared on the lesser curvature. The liver seemed normal. The round ligament was divided with the electric cautery. A portion of the mesocolon which was adherent posteriorly was also removed with the stomach. This impaired the circulation to the transverse colon, so part of the transverse colon was excised and union was made end-to-end according to the technic of Kerr. The operation lasted two hours and thirty minutes. The pulse was 70 at the beginning of the operation and 78 at the end.

The specimen consisted of the pyloric end of the stomach and a part of the transverse colon. The specimen of the stomach measured 14 cm. at the greater curvature and 9.5 cm. at the lesser curvature. There was a lymph-node along the greater curvature near the duodenum which was 3.25 cm. in diameter. Both the anterior and posterior walls of the stomach were
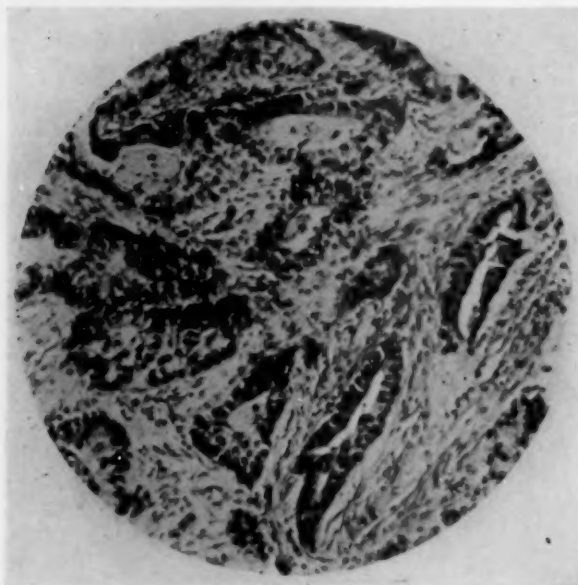

Fig. 10.—Photomicrograph from specimen in the preceding three figures. The histology is that of adenocarcinoma in which the cells are fairly well differentiated and shows histologically a mild degree of malignancy. (× 150.)

extensively invaded. Anteriorly there was attached a portion of the round ligament of the liver 10 cm. long which had been severed with the electric cautery. (Fig. 7.) Posteriorly there was attached a portion of the mesocolon. (Fig. 8.) Besides the large lymph-node there were several smaller lymph-nodes along the greater curvature, and none along the lesser curvature. Internally the growth showed an excavating ulcer with everted margins. (Fig. 9.) The specimen of the colon appeared to be normal. It was removed because of interference with its nutrition. Microscopic section showed adenocarcinoma of the stomach of a rather mild degree of malignancy. (Fig. 10.)

The patient made a fairly satisfactory recovery except that infection appeared in the abdominal wound, and a fecal fistula developed from the transverse colon. A slough was eventually discharged and the fistulous opening closed. He left the hospital on May 5, 1927, with pulse 70 and temperature 98.

On February 6, 1928, he returned for examination. Until a few weeks before this time his health seemed to have been good. Examination showed a mass in the upper right quadrant of the abdomen which appeared to be an enlargement of the liver. It was smooth and extended to just above the navel. The patient's general condition appeared fairly good. There is evidently metastasis in the liver. The patient was living when last heard from, but of course the outcome will be fatal.

CASE V.—C. B., male, white, age seventy-five, farmer, entered the hospital on

May 24, 1927, complaining of "stomach trouble." He was much emaciated and his arteries were markedly sclerotic. He had lost fifteen pounds in weight during the past year. The illness began about a year before admission, with pain in the pit of the stomach which was increased by eating coarse foods and meats. He was free from symptoms while the stomach was empty. Light foods did not cause pain. He had not vomited nor passed blood by bowel. He suffered somewhat from nausea.

May 27, 1927, a partial gastrectomy was done. The disease was quite extensive, though his stomach was fairly movable. There were enlarged lymph-nodes along the lesser and the greater curvatures. After removing the stomach it was found that a suture, where a part of the mesocolon adherent to the stomach had been removed, involved some of the vessels in the mesocolon. The transverse colon, however, seemed to have a feeble circulation, and it was not resected. The operation lasted two hours. The pulse was 60 at the beginning of the operation, and 70 at the end.

The specimen consisted of the pyloric portion of the stomach which measured 13 cm. along the greater curvature and 12 cm. along the lesser. There was an infiltrating mass in the anterior wall of the stomach. There were several enlarged lymph-nodes along the greater curvature, and a few small lymph-nodes on the lesser curvature. Most of the lymph-nodes on section showed that they contained adenocarcinoma. There was in the large infiltrating mass in the anterior wall of the stomach a shallow ulcer which was about 4 cm. in diameter. The margins were firm and raised. Microscopic section showed adenocarcinoma of moderate malignancy.

The patient did well for six days; then his temperature rose to 102 and pulse to 110. The wound was infected. Under local anæsthesia the wound was opened and it was found that the transverse colon was gangrenous for about 5 cm. It was resected and an end-to-end union was made. There followed gangrene in the abdominal wound. Much of the skin and fat sloughed away. The sutures in the transverse colon broke down and a full fecal fistula resulted. There seemed to be but little effort to heal. The patient died of exhaustion on June 28, 1927. Apparently the wound in the stomach healed satisfactorily but a short while before he died a small gastric fistula occurred.

The chief error in this case was in not resecting the transverse colon at the time of the partial gastrectomy, as had been done in the previous patient.

SUMMARY

Of these five patients, all men, the oldest was seventy-seven years, the youngest seventy; the average age was seventy-three. After a rather long operation no patient left the table with a pulse rate over 80, the average pulse rate on leaving the table for the group being 73.

In four of these cases there was very advanced carcinoma. In two of these four it was necessary to resect the transverse colon, and in one of the cases in which the transverse colon was resected some of the round ligament of the liver was also removed.

In Case II and in Case III the history is suggestive of a previous benign lesion in the stomach as an etiologic factor in the cancer. In the other three cases the cancer apparently arose without any history of preceding "stomach trouble".

In Case III, though the cancer was not advanced, the histologic structure showed a high degree of malignancy. This patient lived for several months in comfort and died eight and a half months after the operation from an intercurrent disease.

Of the three other patients surviving the operation, one died about two

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years after operation, having had sixteen months of good health. Another patient is living with a metastasis in the liver, thirteen months after the operation. Another died ten months after operation, having been in good health for five months.

While the results cannot be said to be brilliant, each of the four patients that survived the operation had several months of good health. When the advanced stage of the disease, the age of the patients and the necessary extent of the operation are considered, it would seem that under the circumstances the relief obtained justified the procedure.

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DISCUSSION: DR. EMMET RIXFORD, of San Francisco, Calif., said that he supposed that just because the patients are elderly the type of malignancy is less vicious than in younger people, and that the tumor is more apt to occur at the pylorus where it produces early symptoms and therefore is more favorable for excision than in carcinoma in younger people and in other parts of the stomach.

He recalled the case of an old lady of seventy-one who was ready to die of starvation; had had no food for six weeks except by rectum, but refused operation. Her family finally insisted that something be done. The pylorus was removed. It was as pretty a case as one could wish for, of a tiny tumor that caused complete obstruction. She made an uninterrupted recovery, and at the age of seventy-eight blew up with intestinal distention from a new carcinoma of the sigmoid. It may not have been new, but it was at least another carcinoma. This was removed, and the patient likewise made a good recovery and went into an old ladies' home, passed her ninetieth birthday and was not very far from a hundred when she finally died from something other than carcinoma.

PYLORIC ACHALASIA AND PEPTIC ULCER

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AND

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Achalasia is the term applied by Hurst to persistent failure of a sphincter to open widely in response to that coördinating mechanism by which visceral contents are intermittently retained and propelled.

In this paper pyloric achalasia is arraigned; as a cause of chronic dyspepsia; of ulcer symptoms in the absence of ulcer; as a contributing factor in the development of peptic ulcer; and as an underlying reason for its chronicity.

The pyloric sphincter, five or six millimetres wide and a quarter as thick, is shown by dissection as a distinct anatomical and by function as a distinct physiological entity. If relaxed it may not be palpable as such in the open abdomen, but its position is marked by its short stubby transverse veins; and when contracted, it and the region of the pyloric canal may be both seen and felt as a blanched nodule. Its blood comes from the pyloric branch of the hepatic artery.

The sphincter receives sympathetic and parasympathetic (vagus) fibres, the latter ending about local ganglionic cells and the weight of evidence from clinical and experimental results indicates that the former are for contraction and the latter for relaxation.

Concerning the nervous control of the pylorus there is some dispute between those who hold that vagus influence is for contraction and sympathetic for relaxation and those who maintain the reverse of this theory. Hughson supports Latarject's belief and concludes from his experiments on dogs that vagal stimulation causes contraction of the pylorus and that reflex pylorospasm is prevented by section of the vagus. Thomas and Wheelon contend that the pylorus is not a separate functional entity with a special nerve supply; that it has a double innervation consisting of motor and inhibitory nerves by way of the vagi and splanchnics, both nerves being mainly motor. May says that the splanchnics have no direct influence either motor or inhibitory on the musculature of the stomach and that vagal stimulation causes first inhibitory and then augmentor effects on both the musculature of stomach and on the cardiac and pyloric sphincters. In experiments on the pylorus it has been difficult to distinguish between purely vagal and purely sympathetic effects, since the nerves in this region contain fibres of both types. According to Gaskell's studies on the involuntary nervous system all sphincters receive their contractile nerves from the sympathetic system and their inhibitory nerves from the parasympathetic system, the vagus nerve belonging to the latter system. Elliott proved that the ileocæcal sphincter conforms to this plan. Nakanishi showed in the rat that the main effect of the vagus on the pyloric sphincter is inhibition and that of the sympathetic is contraction and also that adrenalin causes the same effect as sympathetic stimulation. Schafer produced spasm of the pylorus by injection of adrenalin into the

suprarenal vein. Klee and Koennecke produced contraction of the pylorus by sympathetic stimulation. In his clinical studies Fraser favors the views of Gaskell. Pirie believes that hyperadrenalism may be a cause of pyloric hypertrophy and stenosis of infancy.

Pyloric achalasia meaning failure of inhibition by which the sphincter remains closed but not spastic is the result of disturbed correlation between sympathetic and parasympathetic control. Such disturbances may be caused by preponderance of sympathetic influence or by partial or complete paralysis of parasympathetic or vagal fibres.

The normal mechanism of the pylorus seems to have little to do with the emptying time of the stomach since Alvarez has shown that gastric waves often seem to fade away or get reversed just before reaching the sphincter so that many human stomachs fail to empty properly in spite of good peristalsis and a patent pylorus. Achalasia and spasm of the pyloric sphincter may cause some degree of gastric retention but
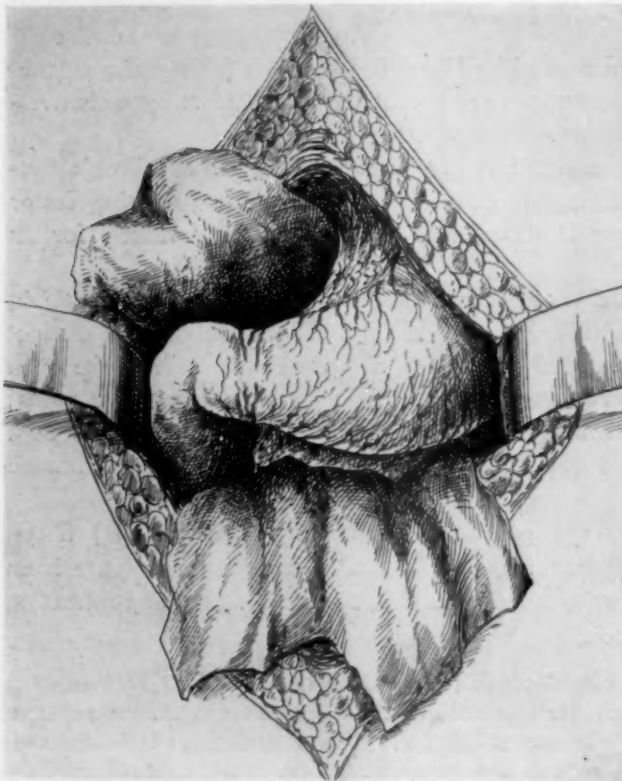

Fig. 1.—Location of pyloric sphincter at distal end of stomach marked by short transverse veins.

will not completely withstand the peristaltic push so that emptying, although delayed, is finally accomplished by hypermotility. Such delay prolongs the action of hydrochloric acid in the stomach and has been shown to be an important factor in retarding the healing of experimentally produced gastric ulcers.

An important function of the pyloric sphincter has to do with the control of duodenal regurgitation which is a natural phenomenon occurring during both the digestive and interdigestive phases. Boldyreff's work which has been confirmed by many others showed that the gastric juice which when formed contains 0.5 per cent. hydrochloric acid is later reduced for purposes of digestion to 0.15 to 0.2 per cent., the equivalent of a titration of 45 to 55 decinormal sodium hydroxide. Attention may be called here to the fallacy of attaching pathologic significance to high acid values obtained by the usual

method of gastric analysis. Equally high acid titrations have been obtained in normal stomachs as have ever been recorded in gastric or duodenal disease. The maximal strength (0.5 per cent.) of acid is secreted by the normal stomach so that the titer valve will depend on the degree of neutralization which obtains when the sample for analysis is removed. The regulation and reduction of gastric acidity to an optimal level is accomplished by the regurgitation of alkaline juices, principally pancreatic juice, from the duodenum. During normal digestion, duodenal regurgitation begins at the peak of the curve of free hydrochloric acid and this process of neutralization continues as the rising curve of the inorganic chlorides crosses the falling curve of the free acid. Thus the curve of the inorganic chlorides becomes the index of duodenal regurgitation. Therefore the varying values of gastric acidity depend upon the efficiency of duodenal regurgitation over which the pyloric sphincter exerts the main controlling influence. Under normal conditions the sphincter maintains a nicely balanced gastro-duo-
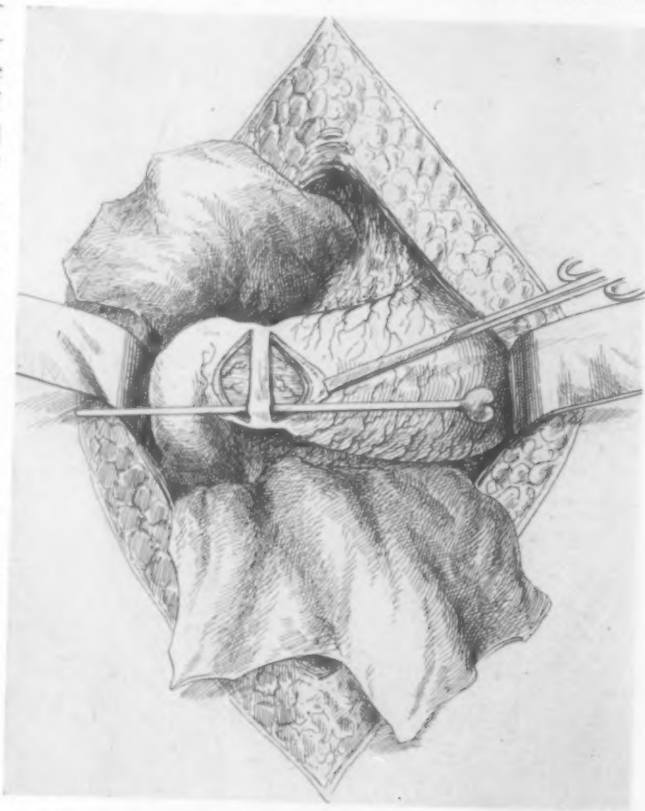

FIG. 2.—Anterior half of sphincter prepared for removal by two elliptical incisions through outer coats of stomach and duodenum, showing the unopened underlying submucosa.

denal correlation but when it is affected by achalasia or spasm it may partially or completely prevent regurgitation into the stomach, and thereby cause hyperchlorhydria by preventing neutralization of the newly formed hydrochloric acid. Because of the difference in force between gastric peristalsis and duodenal regurgitation, the latter may be markedly disturbed by achalasia or spasm of the sphincter although there may be no significant delay in the emptying of the stomach.

Bolton has called attention to the importance of pyloric tone in the regulation of gastric acidity and he believes that hydrochloric acid is the agent mainly responsible for the maintenance of peptic ulcer. It is well known that gastric analysis in some cases of ulcer reveals normal values and that very

high acidity may occur in the absence of ulcer and without symptoms. Gastric analysis affords us very little insight into the chemical workings of the stomach, and practically no information regarding the properties of the material which passes through the pylorus, both during digestion and when the stomach is empty of food. The strength of acid impinging on the first portion of the duodenum is the important factor in the development of ulcer. Beyond this point excessiv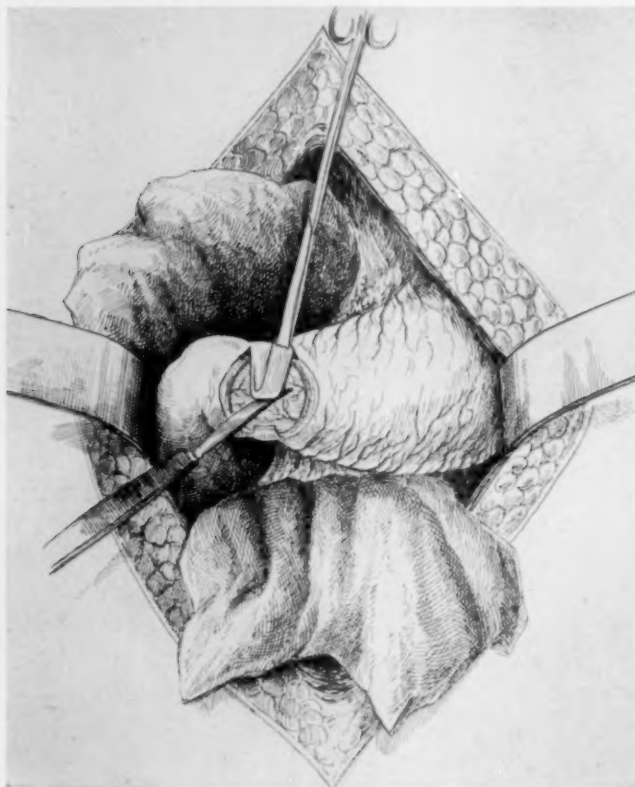e acid is quickly neutralized so that ulcer in the lower duodenum is almost unknown. The strength of acid which is ejected through the pylorus against the duodenal cap is determined by the degree of neutralization in the stomach which in turn is dependent upon duodenal regurgitation.

FIG. 3.—Anterior half of sphincter being removed from the underlying submucosa.

The strategic position occupied by the pyloric sphincter imparts to it potential powers of mischief for the well-being of both the stomach and duodenum. Its irritability and sensitiveness to reflex stimuli are registered by an increased tonus or failure of normal relaxation. Such disturbance of function gives rise to changes in the chemistry of the stomach and in the nature of the material which continually strikes the first portion of the duodenum. There are various sources for these reflex stimuli; the most common being lesions in other abdominal viscera. The initial symptoms of most inflammatory lesions of the abdomen are manifested by gastric disturbance which can be accounted for by abnormal behavior of the pyloric sphincter. The symptoms in chronic cases of extra gastric disease often lead the unwary diagnostician to suspect disease of the stomach. Hughson showed that pylorospasm often follows a simple incision of the peritoneum. In surgical experience appendicitis and cholecystitis are the most frequent causes of pyloric disturbance. The röntgenologist often demonstrates it.

The irritability of the pyloric sphincter is responsive to stimuli emanating from the central nervous system which may be the result of various irritations both mental and physical. It is characteristic of the symptoms of peptic ulcer to be initiated and accentuated by mental worry and strain. That many individuals with ulcer have an inherent tendency toward this type of nervous gastric instability is recognized by those who deal with many cases of ulcer, and to it has been attributed in some measure the failure to obtain satisfactory results from either medical or surgical treatment.

Moynihan, Hurst, and others believe that the tobacco habit is an important etiological factor in peptic ulcer. In a reported series of cases presenting a typical history of duodenal ulcer, but in whom ulcer could not be demonstrated, a large number were users of tobacco and in 90 per cent. of the latter the X-ray showed pylorospasm. Nicotine may cause pyloric achalasia by its paralytic action on the sensitive vagal ganglia of the pylorus.

Infantile pyloric hypertrophy may be the result of intermittent clonic spasm of the sphincter beginning in intrauterine life and caused by preponderance of sympathetic influence or by impaired or tardy development

FIG. 4.—A, anterior half of sphincter removed. Closure of defect by suture which approximates outer coats of stomach and duodenum. B, diagrammatic view of completed operation.

of vagal inhibition. An excess of adrenal secretion which is a powerful stimulant to the sphincter may be a factor. From the standpoint of the relationship between dysfunction of the pyloric sphincter and peptic ulcer it is significant that infantile pyloric disease and peptic ulcer occur with much greater frequency in males than in females.

The symptoms of duodenal ulcer are well defined and when faithfully elicited afford a diagnosis with only a small percentage of error. The early symptomatology while characteristic leads with disturbing frequency to operations at which no ulcer can be demonstrated. In other words, the symptoms of duodenal ulcer are sometimes present in the absence of ulcer. In these cases, gastro-enterostomy fails, but Bastianelli and Shoemaker, the former by

the Rammstedt operation and the latter by partial excision of the pyloric sphincter have obtained satisfactory results. The existence of ulcer symptoms in the absence of a lesion probably indicates that ulcer is not necessarily the cause of the peptic ulcer syndrome, but that the latter is a manifestation of disturbed function of which ulcer may be a sequel. According to Hurst, peptic ulcer is insensitive to even a high concentration of hydrochloric acid. In absence of peritoneal irritation, pain from the gastro-intestinal tract is usually indicative of obstruction. Spasm of pylorus which may be painful in itself offers an obstruction to propulsive efforts of the stomach with resulting distention of antrum proximal to the sphincter—an adequate explanation of pain.

The symptoms in uncomplicated duodenal ulcer are often absent for periods of weeks or months although an ulcer undergoing repair has often been demonstrated in this interval. Symptoms are likely to be precipitated by nervous strain or by an indiscretion in diet. Such phenomena support the opinion that the symptoms attributed to ulcer do not depend upon the presence of an ulcer and can be explained by quiescence or abnormal activity of the pyloric sphincter. The fact that ulcer is present in the majority of patients who have the characteristic symptoms means that pyloric dysfunction, *i.e.*, achalasia or spasm, which is the cause of symptoms, if long continued, favors the development of ulcer.

Experimental peptic ulcer has been produced by a variety of methods, and it is characteristic for most of these ulcers to heal promptly. According to Aschoff, acute ulcers occur in the stomach and duodenum with surprising frequency. In about 10 per cent. of necropsies on adults, there are scars of healed peptic ulcers and in most of these cases there has been no history of ulcer. Chronic peptic ulcer is a lesion different from any of the above and is dependent for its maintenance on some change in gastro-duodenal physiology which for reasons previously cited is induced by pyloric dysfunction. By his method of surgical duodenal drainage Mann has produced with regularity an ulcer in the transplanted jejunum which in most respects resembles clinical duodenal ulcer. In these experiments, McCann found a normal gastric chemism. Such results seem to show that the jejunum cannot withstand the action of normal gastric juice and serve to emphasize the importance of the chemical factor in the causation of ulcer. Boldyreff noted that a duodenal ulcer sometimes occurred after ligature of the pancreatic ducts. It seems to be generally agreed upon that experimental gastric ulcers are slower in healing when emptying of the stomach is delayed. Bolton has shown that exposure of the gastric mucous membrane to an excess of free hydrochloric acid or to the prolonged action of normal gastric juice causes gastritis and the formation of multiple small ulcers. By appropriate tests Bolton, Elman, and Ochs have found that in clinical peptic ulcer there is delay, inefficiency, or failure of duodenal regurgitation to neutralize free hydrochloric acid in the stomach, the result of spasm or achalasia of the pyloric sphincter. It is not uncommon for the observant surgeon to find hypertrophy of the pyloric sphincter in cases of duodenal ulcer.

The surgical procedures practiced in the treatment of peptic ulcer endeavor by chance or design to reduce acidity in the stomach and their efficiency has now come to be measured by the success or failure of this result. The degree of neutralization of acidity during the digestive and inter-digestive phases of the gastric cycle is not reflected in the analysis of the usual test-meal. The truth of this statement is attested by the fact that gastro-enterostomy cures many cases of peptic ulcer without appearing to change gastric acidity. In a reported series of sixty-nine cases of gastro-enterostomy complete anacidity was obtained in less than 3 per cent., yet the larger clinics report 85 to 90 per cent. cures of duodenal ulcer by this pro-cedure. Elman's studies have shown that in successful cases of gastro-enter-ostomy duodenal regurgitation and neutralization which were previously deficient due to interference by the pyloric sphincter have been increased by the operation. Other effects of gastro-enterostomy as shortened emptying time and relief of gastric tension are of secondary importance since excess acid or prolonged action of normal acid strength is the harmful factor. When a properly indicated and performed gastro-enterostomy fails, it does so by insufficient regurgitation through the pylorus or through the new stoma. The result is reactivation of the old ulcer or the formation of a new one near the anastomotic line. Gastro-enterostomy must accomplish more than normal reduction of acidity since the jejunum in some cases is probably vulnerable to normal gastric juice.

Partial resection of the stomach accomplishes the most decided reduction in gastric acidity because in the area removed are located the cells which stimulate acid secretion and cells directly responsible for acid, but the prin-cipal reason for low acid values is the very free regurgitation of duodenal contents provided for by the large anastomotic stoma. Acid cells are not entirely confined to a limited area of the stomach, so that the part remaining after resection secretes acid of the same strength but in less quantity, as formerly produced by the resected portion. The result of the operation is simply that neutralization is more than normally efficient. If for any reason it is not so, and such cases are being reported, jejunal ulcers form as they sometimes do after gastro-enterostomy. Success of operation will depend upon completeness of removal of acid cells and the efficiency of regurgitation to neutralize any acid that may be formed. The former is highly problematical and when it fails the only recourse is removal of more stomach.

Various methods of pyloroplasty have been practised with some success. but not enough to justify general adoption. The reasons for failure as shown by X-ray studies and re-operations are that the activity of the sphincter was not completely abolished or that scar tissue and contracture produced obstruc-tion at the outlet of the stomach.

There can be no doubt that some cases of verified peptic ulcer heal under medical management and in many of these symptoms recur when treatment is interrupted. Alkalies by mouth supply the deficiency of duodenal regurgi-tation and atropine in sufficient doses inhibits acid secretion, but such effects

cannot be conveniently maintained. The basic disturbance, pyloric achalasia, remains unaffected or readily recurs. Regarding the medical treatment of peptic ulcer, Crohn and Reiss say, "Unless relief is had from the pyloro-spasm, we fail to note the disappearance of subjective symptoms." Gastric ulcer may heal in the absence of any form of treatment. Both Lewisohn and Whipple cite cases in which gastric ulcers verified by operation were shown at autopsy to have completely healed although no form of treatment had been carried out.

In the treatment of duodenal ulcer, Judd prefers excision of the ulcer combined with removal of the anterior half of the pyloric sphincter, complet-ing the operation as a gastro-duodenostomy. Of his cases 60 per cent. were cured and 92 per cent. benefited. Gastric analysis showed little change from the condition prior to operation and the emptying time of the stomach was normal. In patients presenting a history of duodenal ulcer and in whom no ulcer was found nor any lesion to account for the condition, in such cases both Payr and Shoemaker have excised the anterior half of the sphincter without opening the submucosa. They report favorable results.

It is our opinion based on reasons previously given that peptic ulcer whether in the stomach or duodenum owes its existence to spasm or achalasia of the pyloric sphincter. It is possible that this condition could be corrected by appropriate drug therapy if such were known, or by division of the nerves to the part, as advocated by Schiassi, if they could with certainty be identi-fied. A sure method for abolishing the activity of the sphincter is removal of its anterior half.

The procedure for the submucous removal of the anterior half of the pyloric sphincter is as follows:

With the stomach exposed the location of the pyloric sphincter at its distal end is readily identified by the short transverse veins. If there is any doubt as to the exact site of the sphincter mechanical stimulation of the pylorus by tapping with an instrument will cause it to contract when it can be seen and felt.

By drawing the stomach out and to the left the assistant exposes the gastro-duodenal area under tension. The veins above and below the sphincter are ligated by catgut on a curved needle, the ends being left long to act as traction sutures. A transverse curved incision is made on the duodenal side and another on the gastric side of the sphincter. These incisions should be made with a sharp scalpel and carried down to the submucous layer which is recognized by its small blood-vessels. In order to facilitate its removal the sphincter should be thoroughly freed by sharp dissection from the underlying submucosa. The sphincter is now cut across at its lower border. At this point care is necessary to avoid opening into the bowel. Should this occur the opening can readily be closed by suture without interfering with the operation. The strip of tissue containing the sphincter is now peeled from the underlying submucosa with the aid of a scalpel and cut across at its upper border. The only bleeding occurs as a free ooze from

the incised edges of the wound and frequent sponging is necessary to keep the area dry. In order to control bleeding, the defect on the face of the bowel is closed by a continuous suture of fine chromic gut which unites the incised outer coats of the stomach to those of the duodenum over the submucosa.

By experiments on the cadaver and on the dog it has been shown that this operation does not produce narrowing of the bowel nor any appreciable infolding of tissue into its lumen. Scar tissue is reduced to a minimum and leakage prevented by avoiding injury to the submucosa.

For the purpose of mastering the details of the operation it is advisable to carry out the procedure several times on the cadaver when it will be found that it can be done safely and in a brief time.

SUMMARY

Pyloric achalasia is defined by Hurst as failure of a sphincter to relax. This failure, in the case of the pyloric sphincter, is chiefly operative against duodenal regurgitation, the major factor in the reduction of gastric acidity. Thus, incident to retention, there is prolonged exposure of the stomach mucosa to a highly acid content, which in turn is forcefully squirted into the duodenum causing both chemical and mechanical trauma, predisposing factors in the development of ulcer and active factors in its persistence.

The permanent success of gastro-duodenal surgery, exclusive of that applied to malignancy and obstructing deformities, is dependent on ready passage of gastric content and free regurgitation into the stomach of pancreatic and biliary secretion.

Of the methods of insuring these results, Judd's ulcer resection combined with partial pyloromyomectomy, the Finney-Haberer operation and Billroth No. 1 are least disturbing to normal function.

With a reasonably assured diagnosis of pyloric achalasia, in the absence of demonstrable ulcer at operation, or even if a non-deforming, non-obstructing one be present, resection of the accessible portion of the pyloric sphincter without opening the mucosa, offers the least traumatizing method of accomplishing the desired results.

Neither this nor any other operation gives promise of more than transient betterment in the neurotic type of patient characterized by multiple manifestations of autonomic imbalance.

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DISCUSSION: DR. J. SHELTON HORSLEY, of Richmond, Va., said that the operation for partial excision of the pyloric sphincter to relieve pylorospasm seems to have no advantage over pyloroplasty, in which not only the sphincter but the muscles of the pyloric canal, which is about one and one-fourth inches in length, are divided and sutured transversely, thus interposing tissue from the stomach around the gastric end of the incision between the divided ends of the pyloric sphincter. A chain mechanically is just as effectively broken by removing one link as by removing a half-dozen links, but when only a part of the pyloric sphincter is excised as described, the calibre of the pylorus is not increased and the fibrous tissue that takes the place of the excised portion of the pyloric sphincter is a direct connection between the two ends of the pyloric sphincter, and if this fibrous tissue tends to contract it may even decrease the calibre of the pylorus. In the pyloroplasty mentioned, however, additional tissue is interposed between the divided ends of the incised sphincter which should permanently increase the calibre as well as relieve the spasm from the sphincter and the muscles of the pyloric canal.

It must be recalled that the innervation of the pyloric sphincter is different from that of the external sphincter ani, which consists of striped muscle and is innervated as striped muscle usually is, whereas the pyloric sphincter has smooth muscle and contracts partly from the extrinsic innervation of the vagus, but largely through the myogenic influence itself, as Alvarez has shown. It seems probable that even the extrinsic nerve supply of the remaining portion of the pyloric sphincter is not affected by excising an anterior segment of it.

THE DILATED DUODENUM

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Although the literature of surgery contains a considerable number of illuminating articles written by surgeons upon the chronically dilated duodenum, it is only lately that internists have begun to pay any attention to the subject. Books upon internal medicine hardly mention this pathology as differentiated from that of gastric, gall-bladder, or even duodenal ulcer pathology, which it so often imitates. Only one book—that of Duval and his collaborators [1]—has discussed the dilated duodenum in a worthwhile fashion, and only two works on surgery in English, mention anything helpful.

The title of this communication refers to the chronically dilated duodenum. The acute dilatation of the stomach is, I believe, the after-clap of a chronically dilated duodenum developed by some obscure irritation within the duodenum, or mechanical pressure from without at the area of the cause of the chronic dilatation. Rokitanski [2] suggested this in 1849.

In practice, the pathology of the symptomatology of the upper quadrant of the abdomen, particularly on the right side, is daily a question as to the identity of its specific location, and we must acknowledge that it is sometimes difficult to differentiate with accuracy the primary location involved. Something has been done to clear up the maze with which the dilated duodenum has surrounded the symptomatology, not infrequently attributed to ulcer of the stomach or duodenum, cholecystitis, and chronic pancreatitis, but in the absence of positive X-ray corroborative findings, nothing conclusive has been worked out. There are, however, rather suspicious symptoms which may make one think of a dilated duodenum. The Cleveland Clinic [3] has recently published the expression of Doctor Crile and his collaborators in this respect. They think that they have arrived at a position where they may conclude "that chronic dilatation of the duodenum is a clinical entity". As Adams says,[4] discussing the question of diagnosis, "It would seem more reasonable to state as Moynihan has with regard to gastric ulcer, that the only two persons who can make the diagnosis with certainty are the radiologist and the surgeon, and the latter can only do so after the abdomen is opened".

Inflammatory adhesions resulting from gall-bladder infection or duodenal ulcer, not infrequently deform the first or second portions of the duodenum; likewise there may be some angulations resultant from congenital bands, but none of these is apt to produce interference with duodenal function except occasionally, when temporarily so much angulation is produced as to cause more or less obstruction which is reflected in stomach retention. These attachments are supramesocolic and are in evidence symptomatically, causing

discomfort or pain while the stomach is emptying itself after a meal. Most of the dilatations of the duodenum, however, have their origin from sub-mesocolic obstructions. Aside from the occasional congenital bands which may compress the duodenum at its third portion causing more or less dilatation above, practically all third-portion dilatations are caused by the third portion being pressed against the third lumbar vertebra, where it is crossed by the mesentery and its contained blood-vessels. Seymour Barling [5] emphasizes this and says in explanation, "The fixation of the duodenum occurs primarily by fusion of the mesoduodenum with the mesocolon and the structures lying in the neighborhood of the right kidney. The neighborhood of the third part of the duodenum is the pivot around which intestinal rotation occurs, rotation which brings the cæcum across from the left side of the body to the right side of the body, and carries the root of the mesentery of the jejunum and its contained superior mesenteric artery and vein across the duodenum near its junction with the jejunum".

An ascending colon which after rotation descends well down and is loosely fixed to the parietal peritoneum—even having a mesocolon—does, with the lower ileum, cause traction upon the mesentery. This traction results in pressure upon the third portion of the duodenum. It is exaggerated when the cæcum is mobile and it with the lower ascending colon is filled with intestinal contents. Sometimes the accumulating effects of a general visceroptosis may be the determining cause of the production of damming-back symptoms referable to the duodenum.

Personally, I believe with Duval that a series of X-ray studies is the only reliable means of making a diagnosis of a dilated duodenum.

The outstanding symptoms in subjects who harbor a chronically dilated duodenum, as I analyze them, are discomfort or pain in the right upper abdominal quadrant, less often in the epigastrium, pain in the back, usually radiating from the frontal locality; headache, nausea, and often vomiting. There is invariably constipation. There may be occasional attacks of diarrhœa. When the symptoms complained of are mostly constant there is positive loss of weight, sometimes extreme. Those who lose weight are always nervous and generally hyperesthetic.

Let me describe, as I did on another occasion,* one case rather fully, and then bring out briefly corroborating points in several other cases which to my mind may be helpful in differentiating the symptomatology of the chronically dilated duodenum from that of the very common pathology so frequently met with in the right upper quadrant of the abdomen.

CASE I.—A young lady, twenty-two years old, had been seen by me off and on, with her physicians, for an indefinite pain somewhere over the gall-bladder region. This pain sometimes radiated toward her back. Her appendix had been removed. Her chief complaint was migraine, and when she vomited it was always bile—not undigested food. Her appetite was capricious. She was much below weight. She was nervous, *i.e.,* tempera-

* Sectional Meeting, American College of Surgeons, Sioux City, Iowa, November 15, 1927.

mentally so. All resources for a positive diagnosis were again and again exhausted. It was decided that the young woman was probably suffering from a low grade infection of her gall-bladder. She was operated upon by me January 17, 1927, in the Clarkson Hospital. On exposure the stomach and gall-bladder, to my eye and touch, were normal, but the duodenum was markedly dilated by the pressure of a band in the mesocolon, which I could not divide. A duodeno-jejunostomy was done. The patient made a fine recovery, her nausea disappeared, appetite returned, and she was a new young woman. Unfortunately a mishap occurred. Six months later she developed progressive symptoms of an intestinal obstruction. This was taken care of by dividing a band partially encircling the upper ileum. The gall-bladder was removed at the same operation, as her physicians were confident it harbored trouble. My opinion is that this gall-bladder was normal, although the pathologist reported it as a chronic cholecystitis, Grade B. The young woman is to-day in fine health, having gained thirty-five pounds in weight. Her nausea, headache, and nervousness are gone.

CASE II.—A woman, age thirty, a nurse, entered the University Hospital and was assigned to the neurological department, May 7, 1927. Her history showed that in 1900 she had been diagnosed as having a gastric ulcer and had been on diet treatment for one year. Since August, 1922, she had constantly complained of anorexia, nervousness, frontal headache, nausea, and vomiting (bilious). Her appendix had been removed and this operation was followed by another for adhesions. She had had a femoral phlebitis as a complication. Present symptoms: Weight about eighty-five pounds; pain in upper abdomen and back; the whole abdomen hyperæsthetic. At this time I suspected her as suffering from a chronically dilated duodenum and said so. The X-ray report was confirmatory. It said in brief, "Good duodenal cap; second part seems spastic; third part dilated and filled with barium". I did a duodeno-jejunostomy. The gall-bladder was normal. She was in my office recently, has gained twenty-five pounds and is in excellent health. All of her symptoms have disappeared although she says her stomach disturbs her at times.

CASE III.—A man, thirty years of age, a rancher, entered the University Hospital, April 30, 1927. He was thin but rugged. His history dating back, suggested a duodenal ulcer or a mild gall-bladder infection. He had frequent attacks of pain in the upper abdomen and had acquired a mild but positive morphinism which was obscuring. He had headache and vomiting. Careful laboratory tests as to gastric or duodenal ulcer or gall-bladder infection were negative, yet we believed that he had pathology in the right upper quadrant justifying exploration. All that I found was a markedly dilated third portion of the man's duodenum, caused by a compressing mesenteric pedicle. A duodeno-jejunostomy was done. The result was extremely satisfactory. Unfortunately he has drifted and we have lost touch with him.

CASE IV.—A young woman, a nurse, was a headache sufferer and had had several attacks of cholecystitis which interfered with her duties. I operated upon her August 9, 1927. Her gall-bladder looked quite normal but I removed it. It turned out to be a "strawberry" gall-bladder. The third portion of her duodenum was markedly dilated by a peritoneo-mesocolic band which I divided. It was interesting to see the dilated duodenum collapse as the band was divided. The recovery of this young woman has been most satisfactory.

CASE V.—A rather spare woman, age forty-nine, married, no children, entered the Clarkson Hospital, February 1, 1928. For more than a year she had been complaining of headache, nausea, belching, and bilious vomiting. She had complained of pain in the upper abdomen for several years. This pain radiated toward the back. She had lost considerable weight. An X-ray disclosed a very much dilated duodenum. Peristalsis was plainly seen traversing the duodenum and then changing to reverse peristalsis. The entire duodenum hung as a loop—its bottom coming below the crest of the ilium. There was apparently some undetermined interference at the duodeno-jejunal junction. She was operated upon by me February 10, 1928, and a duodeno-jejunostomy done. There

has since been marked improvement in all of her symptoms. The reverse peristalsis is gone and her neurotic condition has changed for the better.

The duodenum in the transverse mesocolon is below the lesser cavity of the peritoneum, lies in a bed of connective tissue and is covered by a single layer of peritoneum. If a hanging, angulated right colon is the offending agent this should be tacked up by some sufficing method. McConnell and Hardman [5] report a large series of such cases successfully treated by this technic. I do not agree with Bloodgood, who advises and has on several occasions resected the cæcum and ascending colon as the proper method of overcoming the difficulty. Good results are obtained by doing a simple, safe colopexy. A duodeno-jejunostomy is the operation of choice when not contra-indicated by a simpler method as a colopexy. The resection of the lower ileum and the ascending colon should be reserved for cases otherwise not promising.

I would like to suggest a warning in regard to the doing of a duodeno-jejunostomy. When the transverse mesocolon is loaded with fat and the subject happens to have a heavy abdominal wall, it may be difficult to expose the duodenum and release it sufficiently to bring it into a position in which a safe technic of a duodeno-jejunostomy is practicable. In such an instance it may be wise to resort to the next best procedure, a gastro-jejunostomy. In a recent instance of this kind my patient died several days after being operated upon, and the autopsy disclosed an acute pancreatitis. There was fat necrosis in the omentum and the head of the pancreas was commencing to break down. Although the pancreas was exposed when freeing the duodenum I was not aware of any traumatism to it.

Again it must be remembered that the duodenum is not always situated as described in our anatomies. The loop may be found at the second lumbar vertebra, sometimes at the fifth, and its position will influence its motility and the ease with which it can be manipulated. Medical treatment of the dilated duodenum is, of course, of value. Diet, the duodenal tube, calomel and saline laxatives, the abdominal belt, posture, knee chest, (the foot of the bed raised) when the colon is at fault, all may be helpful.

Let me make another suggestion. When operating for supposed or known pathology in the right upper quadrant of the abdomen, on exposure of the duodenum, should it seem abnormally dilated, lift up the colon with its attached omentum, and inspect the mesocolon to the right of the mesentery where it naturally crosses the duodenum. You may find more or less dilatation of the third portion of the duodenum requiring surgical procedure.

Physicians should give this subject more attention. The pathology is not very uncommon; a reasonably safe symptomatology may be worked out, and its relief by surgery is satisfying when other means have failed.

Byron Robinson [6] in America and Petit [6] of Paris, a pupil of Campenon, described cases of chronic duodenal obstruction. The former intervened surgically in two patients suffering from various symptoms of indigestion.

operated in 1900, and found no other lesion than a premesenteric dilatation of the third portion of the duodenum. Petit described and executed a duodeno-jejunostomy on the cadaver in 1900. Finney, in 1906,[6] described incomplete stenosis of the duodenum from mesenteric origin, as a cause of indigestion. Important articles by Bloodgood [7] and Kellogg [8] have done perhaps most to direct attention to the dilated duodenum. The personal work of E. P. Quain of Bismark, N. D., and his very recent translation of Duval's book will do much in the future to interest the profession in this neglected field.

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DISCUSSION: DR. LEONARD FREEMAN, of Denver, Col., called attention to a form of obstruction of the duodenum that is a persistence from fetal life. He had seen quite a number of these cases, perhaps because he had been looking for them; because what one does not think of and does not look for one is not apt to see.

The duodenum goes downward a short distance and then across the spine, and then is attached higher up at the duodeno-jejunal angle, the first one-fourth being free, but not the remainder, which is imbedded in connective tissue. In fetal life the whole of the duodenum is free, is much longer, and has a mesentery of its own. This sometimes persists into later life, so that the duodenum instead of passing across the spine rather high up, sinks low, in a long loop, down toward the pelvis. Doctor Summers mentioned such a case in his paper. But when it sinks low down in this way it nevertheless is always attached high up by the ligament of Treitz. That is always a constant point of attachment. Like hanging a rubber tube over a nail, it becomes kinked off at the point of attachment. Not only that, but there is also a twist at this point. This loop of duodenum being free and filled more or less with intestinal contents, sinks toward the pelvis and makes the kink greater. The difficulty being increased, as time goes on, by thickening and contraction of the supporting ligaments.

If those who are operating for dilatation of the duodenum will look carefully, they will find that such a condition as this is responsible much more often than has been generally recognized. It may be corrected sometimes by freeing the point of attachment and sometimes by a duodeno-jejunostomy, according to circumstances.

Dr. Emmet Rixford, of San Francisco, Calif., said that, in connection with Doctor Summers' paper, he was reminded of a demonstration that was made in the Museum at Harvard Medical School some years ago in which a number of wax casts of the duodenum made by the late Professor Dwight, professor of anatomy, were shown. He had injected the duodenum with melted wax. The casts showed very wonderfully many of these variations and particularly the crease on the anterior surface of the transverse portion of the duodenum which is made by the superior mesenteric artery.

Doctor Balfour (in closing) said that although he may have given the impression that partial gastrectomy is to be condemned, there is no operation which will give better results in selected cases. It does not necessarily protect the patient against subsequent ulceration, and when such ulceration does occur the problem of further surgical treatment is much more difficult to solve than when a similar type of operation has been the primary one.

Repeated resections do not appear difficult in a diagram, but it is hardly necessary to say that they may be extraordinarily difficult technically. Worse than this, even if a satisfactory operation has been done from a technical standpoint, one cannot be certain that the patient is going to be in good health afterward.

Doctor Summers (in closing): Apropos of the motility of the duodenum, some ten years ago he was asked to remove a large open safety pin from the stomach of an eleven-months-old child. The X-ray showed the pin in the stomach. He opened the abdomen. The pin was not in the stomach but its point was fastened in the wall of a very mobile duodenum. He could handle the pin, so much so that he was able to manipulate it and close it, instead of opening the gut and taking it out. About a week or ten days later the child passed the pin naturally.

THE VALUE OF THE RECTAL TUBE IN OPERATIONS FOR ACUTE ABDOMINAL CONDITIONS

By Herbert A. Bruce, M.D., F.R.C.S., Eng.

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For a number of years I have been in the habit of inserting a rectal, or more properly speaking, a colon tube, before closing the abdomen after operations for many acute abdominal conditions with such striking results that I thought it worthwhile to bring it before this association in the form of a special communication. I got the idea from seeing Sir Arbuthnot Lane use a long rectal tube in ileo-colostomy, and observing how free these patients were from distention and how easy it was to keep their bowels open.

A colon tube (32 inches long, with an eye at the side as well as the end) passed with a corkscrew motion by an assistant or nurse, can be guided up past the "tricky" rectum and through the sigmoid to the splenic flexure or higher, by the surgeon with his hand in the abdomen. It will then be seen how difficult or impossible it is without such help to pass a rectal tube up to or beyond the sigmoid, as it almost invariably becomes arrested at a point about four inches above the anus and then bends on itself and doubles up within the rectum. With the hand in the abdomen, it can be guided past this point and by alternately feeding the bowel over it and pulling on the tube, it can be made to pass to any distance. It should be passed well above the sigmoid as far as the splenic flexure, so as to ensure its remaining in position. It should then be secured by a stitch to the skin near the anus, and can be left for from four to six days as occasion may require.

The chief benefits to be derived from its use are:

1. It permits of easy escape of gas and prevents distention of the large bowel.

2. By holding the sigmoid flexure and the mesosigmoid across the brim of the pelvis it forms an effective shelf which prevents the small intestine getting into the pelvis.

3. It enables one to give saline and glucose high up into the colon where it will have a better chance of being absorbed, and also to give enemata where they will be most effective.

One of our greatest concerns after an operation for diffuse septic peritonitis, is to get an evacuation of the bowels the following day. This is greatly facilitated if the colon tube is beyond the sigmoid, thus enabling the enema to pass as high as the cæcum. In fact I feel confident that the overdistention of the intestines in paralytic ileus will be prevented in a considerable number of cases by the colon tube. It should be used in all cases of peritonitis from whatever cause: in all cases of intestinal obstruction, whether mechanical or

paralytic, and in many operations upon the female pelvic organs, to prevent adhesions to the small bowel or omentum.

It was found most helpful in a recent case of volvulus of the sigmoid, in which a loop of this bowel was turned over and attached by a firm adhesion to the rectum low down. The sigmoid loop had evidently been in this position for a considerable time, for when the adhesion was separated and the loop lifted out of the pelvis, it immediately fell back into its acquired position. The rectal tube restored it and held it in its normal position, and was left in for a week, at the end of which time it was hoped the tendency to recurrence had been overcome. The patient made a good recovery.

Another typical case was that of a man aged thirty-five, who had a ruptured appendix with diffuse septic peritonitis and paralytic ileus when first seen, four days after the beginning of his attack. The appendix, which was gangrenous and perforated, was removed, adhesions of the small and large intestine were separated and drainage provided, and then a colon tube was inserted up past the splenic flexure to about the middle of the transverse colon. The obstruction was relieved within thirty-six hours and he made a good recovery, which we believed due to a very large extent, to the use of the colon tube.

In many cases the pelvic operations in which, after the removal of diseased organs, raw surfaces were left which could not be peritonized, the expedient of using the sigmoid held in position by a rectal tube has effectually kept the small intestines out of the pelvis and prevented adhesions.

It would seem unnecessary for me to recite further the variety of cases in which a colon tube has been used with great advantage; in fact in which it was believed to have turned the scale in favor of recovery. Any desired medication can be given through the tube in addition to saline or glucose without fear of the rectum becoming intolerant. In the intervals of treatment the tube should be left open, when gas and fecal matter will be found to escape.

Should the bowel become irritated by the tube, which it occasionally does, a warm oil enema will relieve it. If the tube should get plugged, it can be readily cleared by running some warm saline through it.

After an experience extending over many years, I feel confident in advising the use of the colon tube, put in place during an abdominal operation, as a life-saving device. I believe that it is just as valuable and important as the stomach tube has proven to be in preventing death from acute gastric dilatation.

RESECTION OF THE PANCREAS

BY JOHN M. T. FINNEY, M.D.

AND

JOHN M. T. FINNEY, JR., M.D. (BY INVITATION)

OF BALTIMORE, MD.

IN PRESENTING this report of a single case of successful resection of a large portion of the pancreas, it is our purpose to draw attention to a condition possibly enlarging the field for the employment of surgery. Recent additions to our knowledge of the function and diseases of the pancreas, as revealed through clinical and laboratory research, have called attention to the condition reported as one potentially surgical in character. Owing largely, no doubt, to the influence of Mikulicz's well-known opposition, operative procedures of any sort upon the pancreas are comparatively rare—particularly those for primary disease of the gland, involving resection of a portion of its substance. Nevertheless, the literature on the subject of pancreatic surgery, both experimental and clinical, is fairly voluminous. But in a rather careful and exhaustive review, we are unable to discover the report of another case similar to the one we are presenting.

CASE REPORT.—Mrs. C. W. J., age fifty-three years, white, widow, was admitted to the Union Memorial Hospital, Baltimore, December 2, 1927. She had previously been carefully studied by physicians, both in this country and abroad. She was referred to us by Dr. T. P. Sprunt of Dr. L. F. Barker's group, to whom we are indebted for most of the laboratory reports.

Complaint.—Spells of confusion, with mental lapses and strange behavior, during the past four years. Low blood sugar.

Family History.—Father and mother living and well at eighty-nine and eighty-three years respectively. Four sisters and brothers alive and well. One brother died of tuberculosis. Husband died five years ago, at the age of forty-nine, of cancer of the pancreas. Never pregnant.

Past History.—General health fair. Has been nervous and troubled with indigestion and constipation all her life. No serious illnesses. At the age of twenty-seven she had a severe nervous breakdown, characterized by marked depression. From this attack, recovery was slow. For about a year following her husband's death, there was again a period of rather marked mental depression, largely influenced, in all probability, by unfavorable environment. She lived in the same house as her husband's brother, who had an old infantile paralysis, associated with convulsive seizures and mental deterioration. This worried her greatly. She then moved to the home of her father, who was a pronounced religious fanatic. Later, she took up teaching, to occupy her time. She found herself much older than the other teachers with whom she was associated, and had great difficulty in making the new adaptations necessary. It was at about this time, four years ago, and coincident with the menopause, that the first attack occurred.

Physical Examination.—Head: Occasional headache. Has worn glasses for many years. Much trouble with teeth; infrequent tonsillitis; prominence of the thyroid for several years.

Cardio-respiratory.—Essentially negative.

Gastro-intestinal.—Chronic indigestion and constipation; appetite fair. Hæmorrhoidectomy, 1923.

Genito-urinary.—Menses, onset at fifteen years; slight dysmenorrhœa. D. and C. in 1902. Menopause at age of forty-nine.

Skin.—Eczema of hips and perineum twice—in 1921 and 1924. Treated with X-ray each time.

Skeletal.—Negative.

Nervous.—Marked instability; always irritable; easily depressed.

Present Illness.—Began four years ago, coincident with her menopause. At first the attacks were slight and infrequent. The only thing noticed was that she would seem dazed, could not concentrate or think clearly, and sometimes would "see double". The attacks at that time would be of but a few minutes' duration, with no after effects. Since first noticed, they have become steadily worse, more frequent and more prolonged. After a year and a half, she became alarmed about her health, and went to Europe for a rest. During the year spent there, she thinks she had possibly six or eight attacks. They usually occurred before breakfast, but had not as yet come to be definitely associated with the taking of food. Any alarm or trouble might precipitate an attack. Once or twice she fell while walking, but was conscious of no dizziness, and was able to arise immediately and continue. During the past eighteen months, the attacks have increased rapidly both in number and severity, until now they have become of almost daily occurrence,—usually in the morning, before breakfast.

A typical attack is described as follows—she can generally tell when one is imminent by her eyes. If reading, they become crossed and she has great difficulty in properly focusing them. Or, they may become fixed in a stare, with dilated pupils. Then the head begins to jerk unsteadily and roll from side to side. Then she cries out. At the height of the attack, she screams and throws herself violently about—almost like a convulsion. There is at times some frothing at the mouth. There has never been any biting of the tongue, or other physical injury during an attack, nor any loss of sphincteric control. Everything that occurs during the attack is hazily remembered by the patient afterward. She feels exhausted, both mentally and physically. The attacks last from fifteen minutes to several hours. Upon one occasion she says she was semi-conscious for a whole day. The most interesting feature about these attacks is that they may be aborted in a few minutes if, at the first warning of their approach, the patient takes a few mouthfuls of shredded wheat biscuit and cream. If the attack is allowed to progress further, the time of recovery after taking food varies, but the patient says it is not as prompt now as a couple of years ago. From September to December, 1926, while under treatment at a sanatorium, on forced feedings and bromides, she had no seizures at all.

Physical Examination.—Height 5 feet 2¾ inches; weight 140 pounds—about fifteen pounds over average. Temperature, pulse and respirations normal; blood pressure 116/80.

The examination was essentially negative, except as follows—mild gingivitis, with several questionable teeth. There is moderate diffuse enlargement of the thyroid, with one definite nodule about 1.5 cm. in diameter, situated in the isthmus, just to the right of the midline. Several spots of eczematous looking eruption on the hips, and inner-surfaces of the thighs. Examination of the nose, throat, heart, lungs, abdomen, pelvis and neurological system all negative. X-ray examination of the chest, gastro-intestinal tract, skull, sinuses and teeth were also negative. The eye examination showed slight compound hyperopic astigmatism, with slight exophoria and hypophoria—corrected by lenses.

The reports of the various laboratory and chemical analyses are the most interesting data in this case, and on them was based the tentative diagnosis of hypoglycæmia or hyperinsulism, which determined the subsequent course of action. We have reports of analyses made elsewhere during the past two years. These are incorporated with our own.

Urine Examination, September 11, 1925.—Negative, except a little albumin.

Blood Chemistry, September 17, 1925.—Uric acid 5.8 mg. per 100 c.c.; NPN 42.0 mg. per 100 c.c.; Sugar 228.5 mg. per 100 c.c.

One week later, September 25, 1925.—Sugar 134.0 mg. per 100 c.c.; hæmoglobin 94 per cent. Red blood cells 4,864,000. White blood cells 8,500.

Kidney function (phthalein output) 42 per cent. in two hours. Exactly one year later, September 25, 1926, the blood sugar had dropped to 41 mg. per 100 c.c. One month later, October 26, 1926, the fasting sugar at 8 A.M. was 79 mg., which following a glucose tolerance test rose rapidly to 232 mg. at 8:30 A.M., then dropped slowly to 196 mg. at 9 A.M. and to 192 at 10 A.M. During this time, the specific gravity of the urine varied from 1.010 to 1.020, but at no time was there any sugar in the urine.

During May, 1927, a blood sugar report was 30 mg., fasting, and only 70 following glucose. The laboratory observations made just prior to her admission to the hospital for operation show essentially the same findings.

Gastric analysis was normal, with free HCl content of 26 per cent.; total acidity of 50 per cent. Stool examination negative. Urine negative, except for faint trace of albumin. A wide series of protein sensitization tests were all negative. Blood Examination: October 3, 1927. Hæmoglobin 80 per cent. Red blood cells 4,506,000. White blood cells 6,200, with a normal differential and platelet count and no abnormal cells. Blood Wassermann was negative. Uric acid 3.4 mg. per 100 c.c. NPN 34.5 mg. per 100 c.c. Blood sugar (fasting) 52 mg. per 100 c.c. Blood sugar the following day (done after basal metabolic test) was 40 mg. per 100 c.c.

Glucose tolerance test showed blood sugar content of 52 mg. before administration; 192 at ½ hour; 135 at 1½ hours; 111 at 2½ hours. This gives a normal reading except for the abnormally low fasting blood sugar to begin with. No sugar appeared in the urine at any time. Two basal metabolic readings, at different times, gave minus 9 and minus 6 respectively. The spinal fluid showed a negative cell count and globulin reaction, negative Wassermann and sugar content of 34 mg. per 100 c.c.

Many subsequent blood sugar estimates were essentially the same as those given above.

There were certain other experiments of considerable interest and importance, which were tried. At one time, ten units of insulin were given hypodermically, with the immediate production of an attack. From this attack she recovered with equal rapidity, following the intravenous injection of a glucose solution. On another occasion, ten units of insulin were given intravenously, together with twenty grams of glucose, without the production of an attack. At the time of these experiments, the blood sugar was at a normal level before the insulin was given. During the attack, it was very low—from 20 to 30 mg. per 100 c.c. Immediately after recovery, following the injection of the glucose, it had again become normal. On the other hand, at another time, while in the fasting state, with a very low blood sugar, near her danger level, a hypodermic injection of 10 minims of adrenalin prevented the occurrence of an attack, and an hour later, the blood sugar was found to be normal. The same result was obtained by the injection of pituitrin, hypodermically and, also, though less promptly, by the use of pituitrin intranasally. Ephedrin solution had no effect whatever in warding off an attack.

Patient was examined by Doctor Hohman of the Department of Psychiatry, who reported as follows: "If it were not for the fact that there is a very striking lowering of the blood sugar and that the taking of carbohydrates aborts the attacks, my feeling would be that these attacks were certainly hysterical".

From these various studies, we felt that it had been shown pretty conclusively (1) that the attacks were always associated with and, therefore, presumably due to, the hypoglycæmia; (2) that there was apparently a plentiful store of glycogen in the body, and that it could be readily mobilized by taking food, or by the exhibition of certain drugs, namely, the injection of adrenalin or pituitrin, or the use of pituitrin as a nasal spray; (3) that there was a marked sensitiveness to insulin, even in exceedingly small doses, as evidenced by the rapid onset of a typical attack immediately following its

introduction. This raised the question as to whether we were dealing with a case of over-production of insulin, or with one showing a marked hypersensitiveness to a normal amount; also as to whether we were dealing with a metabolic disturbance produced entirely by an organic disease, or by a functional disease or by a combination of the two.

In view of the close similarity of the findings in this case to those in the case reported recently from the Mayo Clinic by Doctor Wilder and others, we felt that an exploratory operation was certainly warranted, to determine the condition of the pancreas, and that if then it appeared advisable, a partial resection of the pancreas would be undertaken in the endeavor to diminish the glandular substance concerned in the production of insulin, i.e., Islands of Langerhans. This latter procedure seemed warranted, whether we were dealing with a case of true hyperinsulinism, or one of hypersensitiveness to a normal amount of insulin. In either case, the reduction in the insulin output should, at least theoretically, materially benefit the individual.

The patient was frankly told that such an operation would be in the nature of an experiment, but she was so incapacitated and depressed by the frequency and severity of her attacks, that she was not only willing, but anxious to take advantage of any chance that offered a prospect of relief. Accordingly, she entered the Union Memorial Hospital on December 2, 1927, and the operation was performed the following morning.

In preparation for the operation, the patient was given four drams of glucose every half hour for several doses. Operation was done under ether anæsthesia. An ample left rectus incision was made. From the mid-portion of this incision, and extending laterally below the left costal margin, was a second incision, about five inches in length, the result being a T-shaped opening, giving excellent exposure of the whole upper portion of the abdomen. The approach to the pancreas was through the gastro-colic omentum, the stomach being retracted upward and the transverse colon downward.

On inspection and palpation, the pancreas seemed normal in size, shape and consistency. The liver appeared to be perfectly normal; in fact, on general exploration of the whole abdominal cavity, nothing abnormal was made out. Owing, however, to the persistent, unexplained hypoglycæmia, it was decided to resect a portion of the pancreas, for the reasons above mentioned. Accordingly, beginning at the tail, the pancreas was carefully mobilized and dissected out of its bed until approximately two-thirds of it had been freed. This was accomplished without great difficulty by careful dissection, without injury to surrounding structures and without hemorrhage of any note, except at one point, where it was momentarily feared that possibly the splenic vein had been injured. It proved, however, to be only an aberrant branch, which was easily secured. When as much of the pancreas had been mobilized as it seemed wise to remove—about two-thirds of it—the body of the gland was divided by a V-shaped incision, and the resulting flaps of pancreatic tissue were brought together and sutured with continuous plain catgut, which effectually covered in all the raw surfaces and controlled the oozing therefrom. The line of suture of the pancreas was then turned under and covered with fat and retroperitoneal tissue, by interrupted sutures of plain catgut.

A small wedge-shaped piece was removed for examination from the edge of the left lobe of the liver.

The spleen showed no evidence of disturbance to its blood supply. The toilet of the peritoneum had been so satisfactorily completed that we deliberated as to the advisability of drainage. It was decided, however, in the affirmative, and a cigarette drain was placed in the vicinity of the stump of the pancreas, and another in the bed from which it had been removed. The wound was closed in layers, in the usual manner, with catgut and silkworm gut.

The patient stood the operation well. The blood sugar, from a specimen taken immediately after operation, was 230 mg. per 100 c.c. She returned to her room in good condition. Shortly thereafter, there developed a period of apparent cardiac depression. But, following vigorous stimulation and the administration of 500 c.c. of 10 per cent.

glucose solution intravenously, the patient's condition rapidly improved. The evening following the operation, her condition was excellent—pulse around 90, temperature normal, blood sugar 247 mg.

For the first three or four days after operation, the patient was quite uncomfortable from rather persistent nausea and vomiting, necessitating gastric lavage.

December 4—the day after the operation—the blood sugar was 244 mg., with a two plus sugar reaction in the urine. This was the only time during her hospital course in which sugar was observed in the urine.

December 5, the pulse and temperature both rose rather markedly, the former to 120, the latter to 104. The wound was dressed and showed evidence of slight infection in the lateral incision, although this did not appear to be sufficient to account for the temperature. Blood sugar 140. Blood pressure 120/65. In view of the falling blood sugar, it was thought wise to begin giving glucose again, so this was done in three dram amounts, every two hours. December 6, blood sugar 61.5. December 7, 78 mg., shortly following a dose of glucose. December 8, 57.1. December 9, 57.1.

On the ninth day following operation, blood sugar was down to 44 mg. There was a slight reaction about 11 A.M., when the patient complained of feeling faint and chilly; fingers and toes tingled and the pulse became rather rapid—around 130. Six drams of glucose brought the patient out of the attack almost immediately. Wound in good condition, except for some slight evidence of infection along the drainage track. Last drain removed and Dakin tube inserted. Irrigations with Dakin's solution instituted. There was no evidence at any time of pancreatic fistula, thus confirming our impression at the time of operation that owing to the satisfactory closure of the pancreatic stump, drainage was unnecessary. The danger of the development of retrograde infection along the drainage track, such as occurred here, might thus have been avoided.

From December 12 to December 20, the patient had light attacks almost daily, usually the first thing in the morning; occasionally at other times during the day. None of these attacks were severe, nor did they progress beyond the point of the patient complaining of uncomfortable sensations with a peculiar staring expression of the eyes, facial grimacing and general restlessness. At all times, the administration of a few drams of glucose immediately aborted an attack. It seemed to everyone who saw her that these attacks were much more characteristically hysterical than they had been before operation. The blood sugar during this time ranged from 60 to 45, usually nearer the former figure. The wound was cleaning up nicely, the discharge rapidly diminishing after the institution of Dakin irrigations; sinus tract closing in nicely; pulse and temperature practically normal.

December 20—the eighteenth day after operation—there was quite a severe attack —patient grimacing violently, eye slits widely dilated, kicking her feet in the air and screaming. At all times she was perfectly conscious of what was going on. Within a few minutes of taking a few mouthfuls of shredded wheat, sugar and milk, the attack subsided. It was followed by a crying spell, and the patient was very much depressed for the rest of the day. Vena-puncture was done during the attack and the blood sugar was 50 mg. (A glucose tolerance test the following day showed 60.6 mg. in the fasting blood; 198 mg. after one-half hour; 312 mg. after one hour; 189 mg. at two hours.)

From this date until her discharge, January 20, she remained in a rather depressed frame of mind; sure operation was a failure, but having only occasional, quite mild attacks. Blood sugar continued to vary between 45 and 70. The wound healed rapidly and well, and at the time of her discharge, drainage sinus was reduced to a very small defect, barely admitting the end of probe.

Another psychiatric examination was made by Doctor Richards, with the following report: "I feel that the above-mentioned spells are wholly psychogenic in origin, which one sometimes finds in middle-aged, depressed women. I believe that the low blood sugar is a secondary feature of the picture of distress as a whole, and that it is a phenomenon which has to do with the influence of extreme emotional states upon sugar

metabolism". This report confirms that of Doctor Hohman, made previous to the operation.

Following her discharge from the hospital, the patient returned to one of the sanatoria where she had previously been, for a period of rest and recuperation.

Pathological report on the specimen of pancreas removed *—a portion of grossly normal looking pancreatic gland, irregular in shape and outline, roughly 11.5 x 4.5 x 1.5 cm. in greatest dimensions; weight approximately 22.5 grams. Small wedge-shaped piece of normal looking liver.

Microscopic diagnosis—pancreatic structure apparently normal. There is no demonstrable change in the Islands of Langerhans. Liver normal.

The question, of course, now arose as to whether or not the operation had been of any benefit; whether our diagnosis was correct in considering her a case of hyperinsulism, rather than hysteria, and whether the operation was a justifiable procedure, in the face of a questionable diagnosis. We were dealing with a patient who quite evidently had a very marked back-ground of psychogenic and neurogenic disturbances. She was the type of individual, and at the age, where one would expect such manifestations to play an important rôle, if at all. On the other hand, by repeated examinations, over a long period of time, it was very definitely proven that she constantly ran an abnormally low blood sugar and that, so far as we could determine, the occurrence of her attacks was markedly influenced and apparently dependent upon the periods during which the blood sugar was at its lowest. Moreover, it seemed difficult to believe that anyone could psychogenically influence their metabolic rate to such a marked degree. It is an all too common practice to blame many and varied complaints and phenomena which we cannot otherwise explain, on the hysterical or neurotic temperament of the patient. It seemed, therefore, the course of wisdom to attack the organic basis first, since it appeared that the danger of such an operative procedure as was proposed, although unusual, was not so great as to render such decision unwarranted, rather than arbitrarily to assume her trouble to be purely psychopathic.

The evidence now would seem to point toward a purely functional disorder, since we can discover no apparent disturbance of the pituitary gland, nor of the adrenals, and very little evidence of disturbed thyroid function. It may be that there is some difficulty in the usual mechanism of the mobilization of glycogen, although we know that glycogen can be readily mobilized by the taking of food or by the injection of pituitary and adrenal products.

In view of the apparent influence that the operation had upon the blood sugar level,—for although it did not return to normal, it was consistently higher post-operatively than pre-operatively—would it be unreasonable to suppose that we may have been dealing with a combined functional and organic disease? On such an assumption, we have certainly placed the patient in a better position to overcome the functional element than had we disregarded the organic aspect. Time alone, of course, can tell just how much good has been accomplished.

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* (Dimensions of normal pancreas as given in Gray's Anatomy, 18.5 x 4.5 x 1.5 to 2.5 cm.; weight 60 grams for women.)

At the meeting of the American Surgical Association in May, 1910, we reported a case of successful resection of a large portion of the pancreas, for a solid tumor which we thought at the time was malignant, but which proved to be a benign cyst-adenoma. The status of surgery of the pancreas has changed very little in the intervening eighteen years. There still exists the disposition to regard the pancreas as an organ which is to be surgically shunned, if possible.

Judging from the literature and from personal experience and observation, the commonest surgical condition met with in the pancreas, is the formation of cysts. Since they are essentially benign in character, all that is necessary in dealing with them is excision or enucleation of the smaller cysts, where possible; marsupialization and drainage of the larger ones, when necessity demands, (Santy, Dennis, Riese, etc.).

One branch, however, of the literature has been considerably enriched during the intervening period, by reason of the late World War—that is, the subject of traumatic injury to the pancreas, chiefly in the articles of Wallace, Makins, Maisonnet, Korte, Haberer, Bardeleben, etc., and a number of scattered cases referred to by Riese in his excellent monograph on surgery of the pancreas. There are also occasional reports from civil practice of trauma to this organ. One very interesting article, that of Kubota, deals with the various aspects of experimentally produced trauma of the pancreas in animals.

Acute hemorrhagic pancreatitis continues to be somewhat of a "bugbear" to surgeons, although, fortunately, it is of comparatively rare occurrence, (Hoffmann, Riese, etc.).

Occasional reports are to be found of cases involving resection of tumors. Many of these are cases in which the pancreatic resection was merely incidental to, and necessitated by, a massive resection of stomach or bowel, for malignant growth, which had involved the gland secondarily. (Bier, Kausch, etc.) We have recently removed both the spleen and a portion of the tail of the pancreas, in the course of a sub-total gastrectomy for carcinoma involving all these organs. There are a few isolated reports of resection for primary growths, both benign and malignant. Of the benign tumors, there are on record adenoma, fibroma, endothelioma, angioma and lymphoma. In most instances, the tumors presented no particular difficulty in removal, as they usually enucleated rather easily, (Cohn, Korte, Tancre, Armani, Sendler, quoted from Riese and Kleinschmidt). Of the malignant tumors, there are a few cases of sarcoma and lympho-sarcoma on record, (de Quervain, Martens, Malcolm, etc.). The commonest malignant tumor is carcinoma, usually situated in the head of the pancreas, and hence lending itself less freely to surgical treatment. In Bavaria, Kolb, among 8,777 deaths from cancer in males, found 54 pancreatic cancers; in 11,266 deaths from cancer in females, 50 pancreatic cancers. In two-thirds of all these cases, the tumor was situated in the head of the gland.

In any attempt to eradicate a growth in the head of the pancreas, one is

confronted by the necessity of reëstablishing the drainage of the pancreatic secretions into the bowel. Of necessity, in such an operation, normal drainage through the ducts of Wirsung and Santorini is interrupted. To reëstablish this drainage, various types of operation have been devised, usually involving the implantation of the stump of the remaining gland into the wall of the duodenum or jejunum, (Franke, Desjardins, Sauve, Kausch, etc.). Such a procedure, from a technical standpoint, is extremely difficult, and, from the patient's standpoint, extremely hazardous, and it is doubtful if the results justify it.

The most interesting case, from our point of view, which was found in the literature is that recently reported from the Mayo Clinic, by Wilder, Allan, Power and Robertson. In that case, presumably a primary carcinoma of the Islands of Langerhans, with metastases to the liver and regional lymph glands, we have a condition of the blood sugar quite parallel to that which we have just reported. Influenced largely by that report we reached the conclusion upon which was based the decision to operate in our own case.

SUMMARY

(1) Report of case, perhaps unique, of persistent, marked hypoglycæmia associated with attacks suggestive of either insulin shock or hysteria.

(2) Massive resection of pancreas as means of reducing number and output of Islands of Langerhans.

(3) Feasibility of removal of large portions of pancreas as comparatively safe and simple surgical procedure.

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INTERPOSITION OF A LOOP OF ILEUM TO REPAIR DEFECTS IN THE COLON

By Harvey B. Stone, M.D.

of Baltimore, Md.

In a previous communication,[1] the writer has presented an experimental study on the use of loops of ileum as grafts between the divided ends of the colon, and has referred to the scanty literature on the subject (Vignolo,[2] Soresi[3]). This work was done entirely upon dogs. It proved the possibility of segments of ileum being successfully interposed between the divided ends of the colon, with complete preservation of the functions of digestion and defecation in spite of the abnormal arrangement of the intestinal loops. Vignolo[2] has reported a case that was to all intents a success, although the patient's disease prevented the completion of the operation. It is the purpose of this paper to present a successful clinical case in which this principle has been employed. The report is considered worthwhile, not only because of the success of an extremely novel procedure, but also to call attention to an adaptation of the methods of grafting to a field in which

Fig. 1.—X-ray plate of abdomen before operation, showing tube entering colostomy at point A and barium in colon. Straight descending colon and complete absence of sigmoid.

it is believed it may be used more often, with benefit to the development of abdominal surgery.

The case report, reduced to its essential features, follows:

The patient, a young woman of twenty-seven years, was first seen on January 9, 1928, being referred to me by Dr. Stephen H. Watts, of the University of Virginia. She had undergone two previous operations, the most recent and most important so far as concerns her present condition, being on June 10, 1926. The essential features of this operation, as supplied through the courtesy of the surgeon who performed it, were as follows. Through a midline suprapubic incision, a large mass was found in the left lower abdomen. After much difficulty in exploring this mass, it was found to contain sigmoid, rectum, left ovary and tube. An abscess in the cul-de-sac was opened containing two hundred or three hundred cubic centimetres of thick yellow pus. There was almost complete obstruction at the lower sigmoid and upper rectum, which were almost gangrenous in appearance. As no improvement took place after applying hot packs, it was felt that this portion of the bowel was beyond regeneration. Due to this condition

of the sigmoid and rectum, and to the inflammatory disease of the surrounding organs, a colostomy with drainage was considered the best procedure. An incision was made three inches to the left of the midline, the upper rectum and lower sigmoid were divided and dissected free, and the stump of the sigmoid brought out and fixed in the left-sided incision.
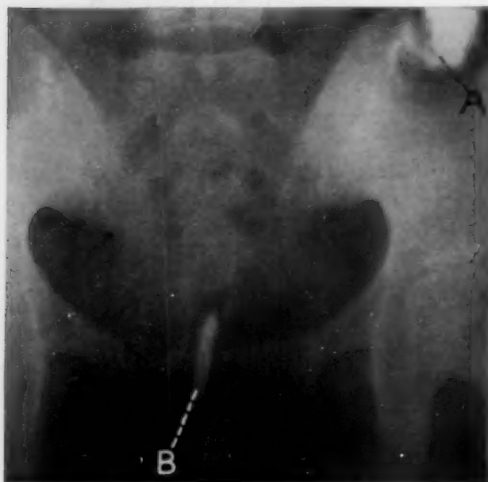

FIG. 2.—Stump of colon at A, containing barium, and rectal tube in short pouch of rectum at B, with large defect between, due to removal of sigmoid.

After a stormy convalescence the patient regained good health, but was left with a terminal colostomy in the left flank. This was a source of great distress and for its relief she presented herself, nineteen months later, to the writer.

On examination at this time she presented the following essential findings. General nutrition and appearance very good. The abdomen shows a scar from the umbilicus to the symphisis, with some diastasis and herniation. There is a left-sided McBurney incision through which the terminal stump of the sigmoid opens. A barium enema given through this stump shows a complete absence of any sigmoid loop (Fig. 1), the straight descending colon opening directly through the stoma. Rectal examination showed a short rectal pouch, haps ten centimetres long, ending blindly. A very tender fulness could be felt above the blind end. (Fig. 2.)

It was decided to attempt a restoration of the continuity of the bowel to the anus, mobilizing the descending colon if possible; if not, trying to bridge the defect between descending colon and rectum by interposing a loop of ileum.

Operation, January 12, 1928, Church Home and Infirmary, Baltimore; ether anæsthesia; the large midline scar, which was found to consist of nothing but skin and peritoneum, was excised. Numerous adhesions were found between the small bowel and the pelvic contents. The descending colon was explored, and found so short that its mobilization was considered inadequate to permit it to reach the bottom of the pelvis. After separation of further adhesions a large cyst of the right ovary about the size of an orange was found filling the lower part of the pelvis. This was removed, thus per-

FIG. 3.—Loop of ileum interposed between descending colon and rectum. Lateral anastomosis at A.

mitting the rectal tube, which had been placed in the stump of the rectum from below, to be felt. It was then decided to proceed with the attempt to use a loop of ileum to span the gap between the descending colon and rectum. A point on the ileum about thirty-five

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centimetres above the ileo-cæcal valve was selected as being the best position for the lower end of the transplanted loop, as at this point the mesentery of the ileum was longest. The bowel was divided here between clamps and the mesentery split down toward its root so as to give a mobile attachment for the stump of the transplanted loop. The ileum was then measured upward so that a long enough loop could be obtained to reach easily from the stump of the rectum to the stump of the sigmoid. The length of the loop thus determined upon was about thirty-five centimetres.

At this level the ileum was again divided between clamps, leaving an isolated loop thirty-five centimetres long attached only by its mesentery. The blood supply in this loop was absolutely satisfactory. The two stumps of ileum above and below the free loop were turned in through purse-string sutures and a lateral anastomosis was done between them, thus restoring the continuity of the ileum. The rectum was then opened at its blind end and the rectal tube drawn up from within it. The opening in the rectum was made sufficiently large to admit easily the index finger. The lower end of the free loop of ileum was passed down over the rectal tube and attached to it by catgut stitches. The rectal tube was pulled downward by an assistant, until the stump of the ileum was invaginated into the upper end of the rectum. It was fixed in this position by seven or eight interrupted catgut stitches and the rectal tube left in place. This completed the anastomosis of the lower end of the loop of ileum to the upper end of the rectum.

The upper end of the free loop of ileum was closed through purse-string sutures and was brought over alongside of the descending colon above the

FIG. 4.—Beginning expulsion of barium enema showing loop of ileum emptying faster than colon.

terminal colostomy. Here a lateral anastomosis was done between the descending colon and the upper end of the free loop of ileum. The colostomy was not disturbed at this operation at all, it being intended to close the colostomy at a second stage. A protective cigarette drain was placed to the bottom of the pelvis and brought out through the midline incision. Openings in the mesentery made by the isolation of the free loop were closed with silk stitches to prevent loops of small bowel getting into them and the abdominal wall was closed in layers with catgut, supported by two through and through silkworm gut stitches. Patient was under anæsthesia about four hours. She left the table in good condition.

An examination of the tubo-ovarian mass removed showed a tuberculous salpingitis and an ovarian cyst. Following the first operation the patient had an irregular temperature for several weeks, sometimes nearly normal and sometimes as high as 102. During this time there was frequent vomiting and crampy pains at intervals in the abdomen, but the bowels moved well per rectum every day and there was very little discharge through the colostomy. It was felt that there was a deep abscess somewhere responsible for her fever. On two occasions openings took place in the midline incision, and discharged a certain amount of pus which was odorless and looked like tuberculous pus. On the twenty-fifth of February a large amount of pus was discharged through the vagina also. On each of these occasions there was a temporary fall in the fever, which returned again in a day or two. March 1, patient complained of some pain in the left

flank and March 3, a definite abscess here was opened under ether, and a considerable amount of pus evacuated. This abscess seemed to be entirely extra-peritoneal. At the same time the colostomy opening was detached from the skin through an oval incision, and turned in through a purse-string suture in an attempt to close it. The incision was packed with gauze and not sutured.

Following this operation the patient gradually improved. Temperature promptly became normal and remained so. Patient's bowels continued to move per rectum normally. Vomiting ceased entirely and so did the abdominal pain. It was quite evident that these unfavorable symptoms had been due to the deep abscess just described. The patient gained weight and was soon up and walking around. However the colostomy closure was unsuccessful. After a few days the sutures on the stump of colon cut out and the bowel re-opened. Very little drainage took place through it and as the patient had been in the hospital a long while, it was decided to let her go home with the colostomy still incompletely closed, hoping that it would close spontaneously. If this fails to take place it should prove a simple matter to close the colostomy at another operation when the patient has completely recovered her strength. (X-ray plates after operation, Figs. 3 and 4.)*

To capitulate briefly, a patient deprived of the whole sigmoid flexure, and existing nineteen months with a colostomy, has been restored to normal powers of defecation by interposing a loop of ileum between the descending colon and the rectum. There are a number of cases being done now in which the rectum is removed with the sigmoid when the latter is diseased. It is possible that in some instances the rectum may be preserved without prejudice to the necessary completeness of the attack on the disease. If such be the case, the method herewith presented offers a chance for the restoration of normal defecation and the avoidance of a life-long colostomy. There is a further possible utility of the same principle. Growths of the descending colon present a special problem because of notorious difficulty in securing good anastomoses between the ends. If the whole left side of the colon requires removal, either because of disease or to avoid the unsafe anastomosis of the descending colon, it would be possible to place a graft of ileum between the transverse colon and the rectum, should this prove desirable.

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* Addendum. Since this paper was written a letter from the patient announced the closure of the colostomy as being practically complete.

THE MIKULICZ OPERATION FOR RESECTION OF THE COLON

ITS ADVANTAGES AND DANGERS

By Walter E. Sistrunk, M.D.

of Rochester, Minn.

FROM THE DIVISION OF SURGERY OF THE MAYO CLINIC

I ASSUME that all members of this Association are familiar with the Mikulicz operation as used for resection of different portions of the colon for carcinoma. In properly selected cases the operation may be safely performed with satisfactory results, but if it is performed in cases for which it is unsuited the mortality is high and there is a strong probability of recurrence of the malignancy in the wound or at the site of the resection. In a broad way the operation may be looked on as applicable for resection only of portions of the colon that are mobile or that may be mobilized without too great injury of the blood supply to the loop that is to be left outside.

The operation is most often used in cases of carcinoma in the sigmoid flexure and in these cases its use should be largely limited to non-adherent growths in sigmoids that have long mesenteries which will easily permit complete withdrawal, from the abdominal cavity, of the loop of bowel containing the growth. In such cases the operation, performed in four stages, may not only be done with a high degree of safety but a sufficient amount of bowel and mesentery may be removed to offer an excellent chance for permanent cure. I cannot emphasize too strongly that its use as a primary operation should be largely limited to the foregoing types of cases. (Figs. 1, 2, 3 and 4.)

It often happens in operating that conditions are found which would contraindicate the primary use of the Mikulicz operation, and in my own experience many of the fatalities and recurrences following this operation have been in such cases.

In cases of (1) adherent growths associated with infection of the wall of the bowel and the adjacent tissues, (2) large growths associated with infection, (3) growths associated with obstruction, and (4) growths in sigmoids with a short mesentery in obese patients with a thick abdominal wall, I believe it is safer to make a slight change in the usual technic.

Adherent Growths Associated with Infection of the Wall of the Bowel and Adjacent Tissues.—Most adherent growths show infection in the bowel wall and adjacent tissues, and contraction or shortening of the mesentery of the involved loop. If the Mikulicz operation is performed in four stages in such cases, the tissues surrounding the growth will necessarily be considerably traumatized in freeing the growth sufficiently to allow it to be lifted out of the abdominal wound. Such trauma probably lowers the resistance of the infected tissues and fatal peritonitis may result. The tissues thus traumatized usually pour an exudate containing virulent organisms into the abdominal cavity, which also may cause fatal peritonitis. If the mesentery is short it is difficult, after adhesions have been freed, to draw the loop out of the abdominal cavity in a manner to prevent the growth from coming in contact with the raw surfaces of the wound. If a loop of bowel containing an infected
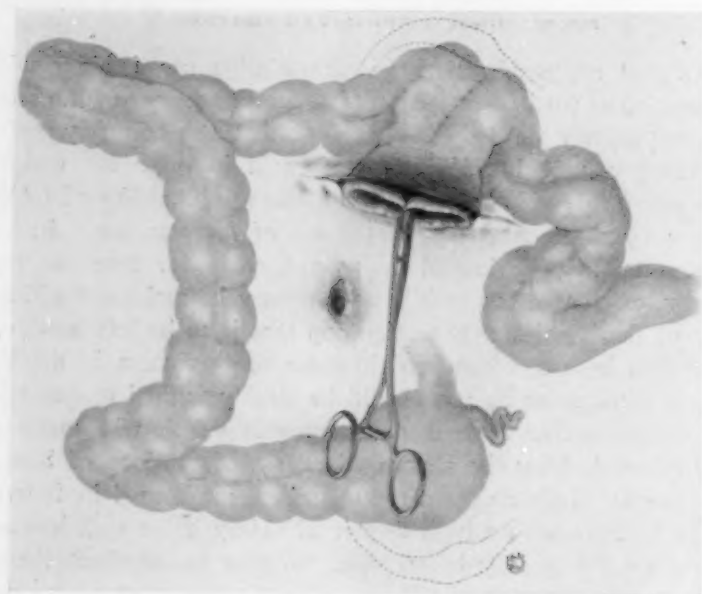
Fig. 2.—Application of clamp to cut out partition between loops of bowel preparatory to closure of colostomy opening.
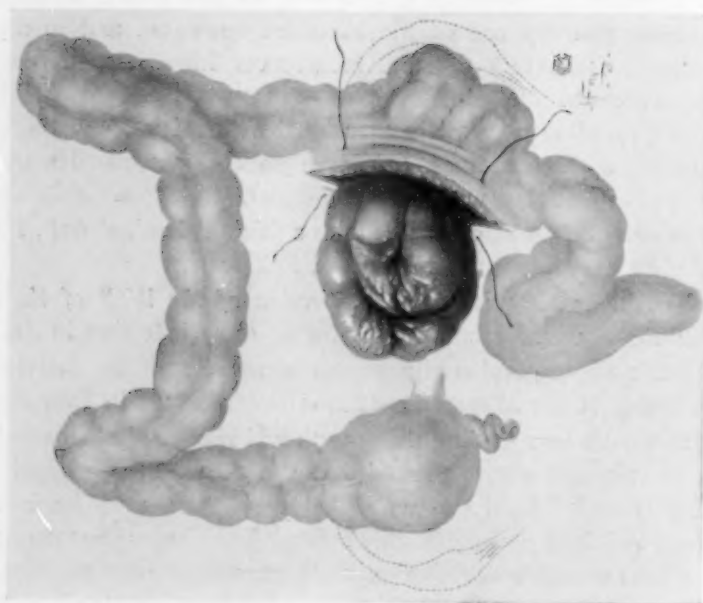
Fig. 1.—Mikulicz operation for resection of carcinoma of the sigmoid. Growth lifted out of abdominal wound.

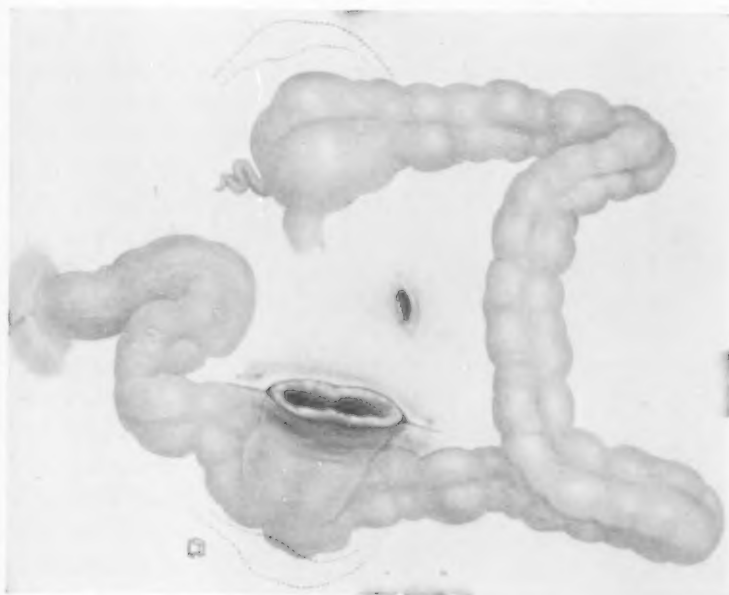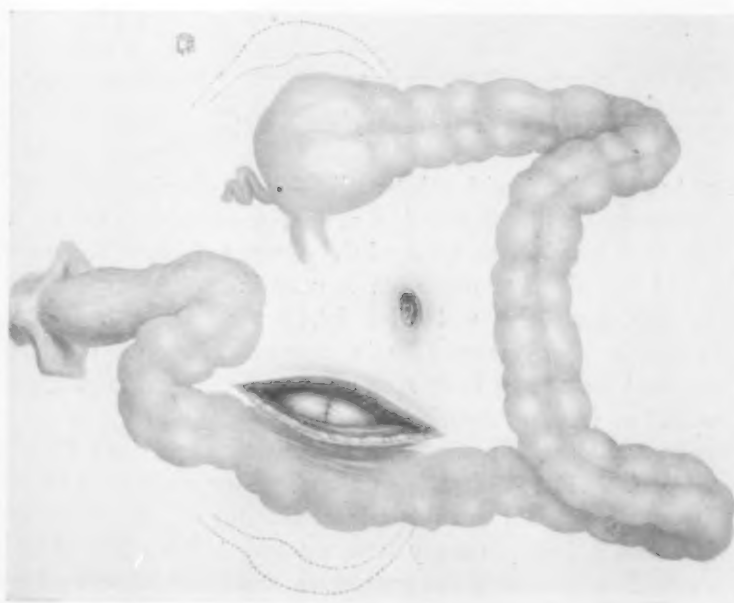Fig. 3.—Appearance of bowel after partition has been cut through with clamp.

Fig. 4.—Fourth stage Mikulicz operation. Closure of colostomy opening. Bowel has been freed from abdominal wall without opening peritoneum, and closed transversely.

growth is left in apposition with the surfaces of the abdominal wound, wound infection and possible fatal peritonitis may occur. Carcinoma cells also are likely to become implanted in the raw surfaces of the wound before the loop has been cut away, and later produce local recurrences. It may not always be possible in such cases to remove as much of the wall of the bowel and of the mesentery as is desired, and recurrence at the site of the resection is likely to develop. If the mesentery of the bowel is short, as is seen in adherent infected growths, so much tension is necessarily used to lift the loop completely out of the abdominal cavity that sloughing of the wall of the bowel through interference with its blood supply may occur, and this may cause infection of the wound.
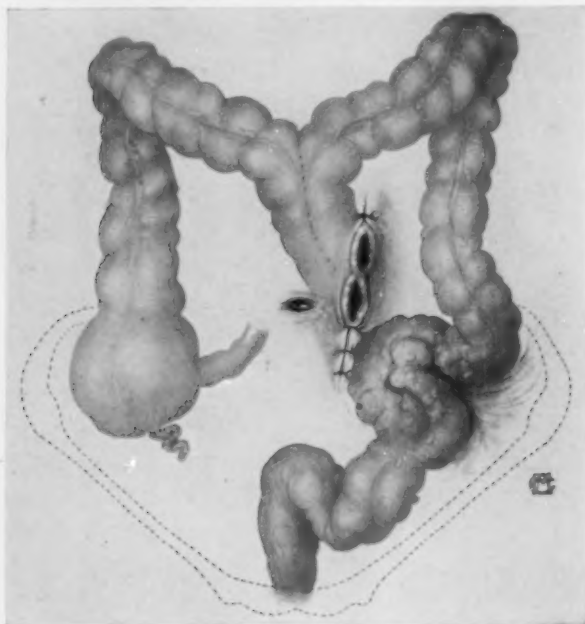
Large Growths Associated with Infection.— Such growths in the sigmoid flexure are usually associated with shortening of the mesentery of the sigmoid, due either to chronic changes resulting from infection or to œdema, and in these cases many of the difficulties noted in the first group are likely to follow such an operation if used as a primary procedure.

Fig. 5.—Colostomy in transverse colon as a preliminary to resection of adherent carcinoma of sigmoid by the Mikulicz method.

*Growths Associated with Obstruction.—*Most carcinomas in the sigmoid flexure associated with obstruction are infected with virulent organisms, which also have invaded the walls of the obstructed bowel for a considerable distance. If the Mikulicz operation is used in such cases, infection of the wound or fatal peritonitis will often follow the operation. Because of the obstruction, it is usually necessary in such cases to open the bowel earlier than usual, and the soiling from such a procedure may also produce infection of the wound or fatal peritonitis.

*Growths in Sigmoids with a Short Mesentery in Obese Patients with a Thick Abdominal Wall.—*If patients are obese the mesentery of the sigmoid flexure is often short and contains a large amount of fat. The subcutaneous fat of the abdominal wall in many such instances is from 6.25 to 10 cm. thick. In such cases, even though the growth is small and associated with slight infection without obstruction, it is often difficult satisfactorily to lift it completely out of the abdominal wound by the Mikulicz method and the loop brought out may be left under considerable tension. The tension may seri-

ously interfere with the blood supply and thus cause sloughing of the bowel, infection of the wound, and possibly peritonitis.

In my experience it has been much safer when operating for carcinoma of the sigmoid flexure to avoid performing the Mikulicz operation or other type of primary resection in any of the foregoing conditions, but first to perform, with as little trauma to the growth as possible, a colostomy in the transverse colon. Colostomy relieves the obstruction and no doubt, by placing the bowel at rest, decreases the virulence of the organisms in the growth and adjacent tissues. Two and a half weeks later, a second operation is performed in which the growth and as much of the mesentery as possible is resected by performing the first and second stages of the Mikulicz operation. The abdominal wall is closed around clamps left on the ends of the bowel and later the two colostomy openings which result from such a procedure are closed simultaneously. (Figs. 5, 6, 7 and 8.)

Occasionally the Mikulicz operation may be used in resecting carcinomas in the ascending colon, but I believe that
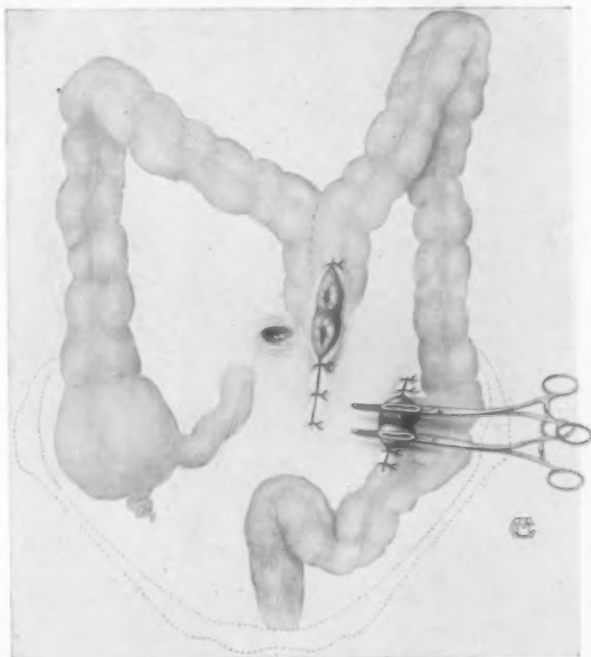

FIG. 6.—Same as Fig. 5 after growth has been resected by first and second stage Mikulicz operation performed simultaneously. Clamps have been left on the ends of the bowel.

growths in this portion of the bowel may be more satisfactorily removed by other methods, and doubt that the Mikulicz operation is often indicated in such cases.

On account of the mobility of the transverse colon, the Mikulicz operation may often be used to resect carcinomas situated in this portion of the colon. In such cases it is usually easy to lift the loop of the bowel containing the tumor well out of the abdominal cavity and the four stages of the operation may be carried out with comparative safety. If the growth is very large, it sometimes seems best to perform the first and second stages of the Mikulicz operation together. Operations for tumors in this portion of the bowel are often performed through longitudinal incisions, and in this event it is necessary slightly to twist the loop of the bowel that is brought out for resection. In such cases obstruction may develop before it is safe to open the loop brought out for resection or to remove the clamps in case the first and second stages of the operation have been performed together. To obviate this com-
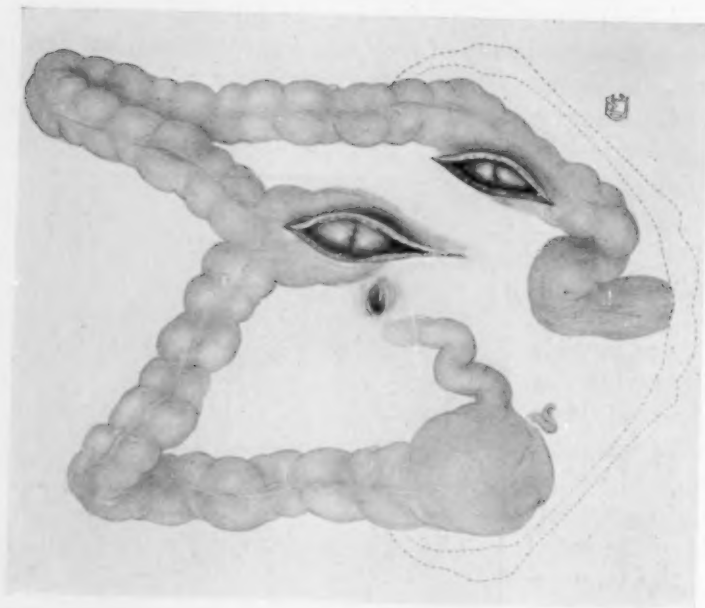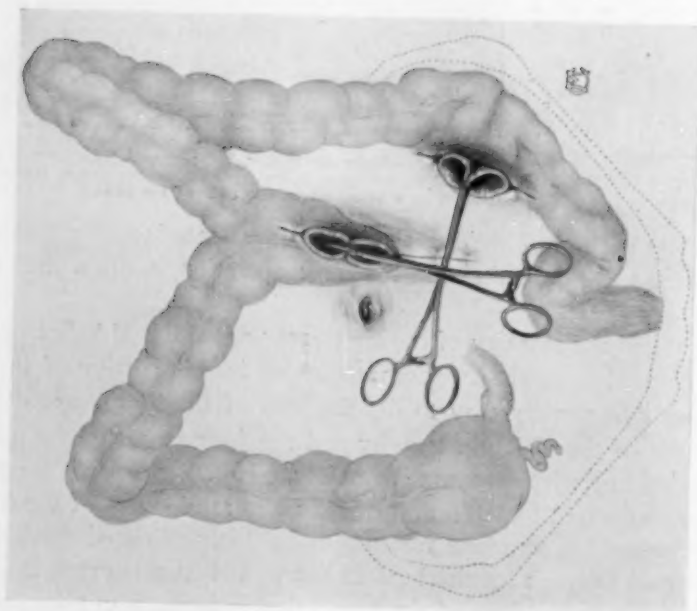
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Fig. 8.—Simultaneous closure of both colostomy openings.

Fig. 7.—Simultaneous application of clamp to both colostomy openings preparatory to closure.

plication, I usually perform, at the time of the primary operation, either an appendicostomy or a cæcostomy.

Small tumors in the splenic flexure with slight infection may be safely resected by the Mikulicz type of operation, if the splenic flexure is sufficiently mobilized to allow it to be completely drawn out of the abdominal wound. Appendicostomy or cæcostomy, however, should usually be performed at the same time. Large infected growths in this situation are, I believe, more safely removed either by primary colostomy in the transverse colon and later resection of the growth or by colocolostomy between the transverse colon and the sigmoid flexure, and after two and a half weeks resection of the portion of bowel short circuited by this anastomosis.

The descending colon proximal to the sigmoid flexure is usually so fixed in its position, and its blood supply is such that it is difficult to make use of the Mikulicz operation for removal of growths in this portion of the bowel. It is probably best to remove them by the method which I have mentioned for resection of large infected growths in the splenic flexure.

I regard the Mikulicz operation, if judiciously used in suitable cases, as perhaps the safest known method for resection of certain portions of the colon for carcinoma. If, however, it is indiscriminately used as a routine operation, regardless of contraindications, I believe it is often a dangerous procedure which may be followed by a high mortality rate and frequently by recurrence of the malignancy.

DISCUSSION ON PAPERS RELATING TO SURGERY OF INTESTINE

Dr. John H. Gibbon, Philadelphia, Penna., remarked as to the limitations which Doctor Sistrunk made to the employment of the Mikulicz operation. This operation undoubtedly is a safe operation, and has been the means of saving a great many lives at a time when surgeons were inclined to do resections.

The mistake is still occasionally made of resecting a large intestine in the presence of an acute obstruction, but it is not made as often as it once was. Of course there comes a time when one has to resect in the presence of an acute obstruction if there is gangrene or possibly if there is perforation. Various attempts have been made in recent years to develop an aseptic resection of the large intestine. He had tried all of them. The last six resections of the colon which he had done had been by the Kerr method. He had had one leakage and no deaths. He was convinced that it has solved the problem of immediate anastomosis. It is much cleaner than the Mikulicz operation. It means one operation instead of two or three or four. In only one of those six cases was a preliminary cecostomy done. That was done for an acute obstruction by another surgeon in another hispital. If in acute obstructions of the large intestine a cecostomy is done in order to have the opening as far away as possible from the growth, one can then later do an aseptic resection of the large intestine, getting in practically every case a primary union and no leakage. The primary cecostomy is a safety valve which is kept open until the calibre of the colon is established. He was convinced that this operation of Kerr's is the best method of resection of the large intestine that has been brought out.

DISCUSSION: DR. CHARLES N. DOWD, New York City, said that the Mikulicz operation is one which he had worked over a good deal and had tried out under various conditions. He agreed absolutely with Doctor Sistrunk and Doctor Gibbon that the performance of a cecostomy is a great advantage where there is obstruction, and that it obviates many of the conditions under which the Mikulicz operation was at first done. However, with our present facilities for diagnosis, there are a large number of cases who have annular carcinoma of the sigmoid, or perhaps of the splenic flexure or transverse colon, on whom the diagnosis is made before they have real obstruction.

One makes an error in considering that the Mikulicz operation consists in simply drawing a loop of diseased intestine outside of the abdominal wall, securing it there and allowing it to necrose. Mikulicz used to do a good deal more than this in his later operations. His procedure diminishes sepsis and thus secures the recovery of some patients who therwise would not recover; but it does not at all necessitate an incomplete operation.

It is not necessary to restrict oneself to a small incision through which a little loop of intestine may be pulled. One should make a large enough incision near the mid-line, when the growth is low, so that a suitable inspection of the pathological condition can be made; so that one can take out what lymph-nodes are necessary; so that one can see whether the liver has metastases in it, and so that one can mobilize the gut and then bring out the desired portion through a separate intramuscular incision in the lateral part of the abdominal wall. The danger of recurrence is no greater and no less than in other types of thorough resection.

On this basis, the afferent and efferent portions of intestine can be stitched together for a suitable distance and proper spur formation thus obtained. The likelihood of hernia is diminished, because the gut comes through a very small incision and the surrounding abdominal wall heals kindly. Temporary ligatures can be applied to the intestine at its emergence from the abdominal wall and the redundant portion can be excised; thus aiding cleanliness.

When operating on these growths of the large intestine he had usually found that there is a great deal of fat in the intestinal wall, that the peritoneum lies close to the intestinal wall only for a distance of one-quarter or one-fifth of its circumference, and that the difficulties of the other kinds of anastomosis are much increased on account of the great deposit of fat which exists around the wall, beneath the peritoneum.

His feeling was that one should not start in on the expectation of doing a Mikulicz operation, in each of these cases. It is better to start on the basis of making a suitable incision and suitable exploration, and then to do whatever form of operation is indicated, being familiar with every detail that may be required for any one of them; hoping to determine the pathology and then to follow along on the basis that is needed.

He thought the Mikulicz operation properly done saves lives.

DR. CHARLES L. GIBSON, New York City, said that Doctor Sistrunk did not mention, and no authority that he had ever consulted or read has ever mentioned, a certain advantage about the Mikulicz operation which became

very evident to him in the first operation he ever did. This was fifteen years ago, on a gentleman who was then sixty-two and is now in sufficiently good health to preside over one of the societies which is a part of this Congress.

He had a carcinoma which had given him symptoms for about a year. At operation there was found a very typical small, tight, annular carcinoma, and a very large, loose, redundant descending colon. He was able to make a very wide dissection, loosening the loop so as to bring out a very long loop, and when the specimen was resected it was eighteen inches in length, so it would seem as if he had probably got well clear of the original disease but when the specimen was examined by a pathologist it was found that on the proximal section of the meso there were cell nests. So he kept the wound open for four months and applied to it the actual cautery once or twice a week, and evidently succeeded in getting rid of those few cell nests.

Dr. EMMET RIXFORD, San Francisco, Cal., called attention to one danger in the matter of the Mikulicz operation that had not been mentioned in the discussion nor in the papers, and that is that often one is dealing with the so-called critical area in the matter of the circulation of the sigmoid. He found this out in a tragic way. He had performed the Mikulicz operation —this was twenty or twenty-five years ago—apparently very successfully. When it came to using the clamp to cut the spur, evidently the blood supply to the lower segment was cut, and the lower segment became gangrenous and the patient died of general peritonitis.

Perhaps one can avoid this by suitably suturing the intestinal loops together and being quite sure that in crushing them with the clamp one cuts down through the suture line instead of catching any part of the mesentery. But every once in a while one will interfere seriously with the circulation of this part of the colon in the area lying between that supplied by the inferior mesenteric and the superior hæmorrhoidal arteries.

Dr. HARVEY CUSHING, Boston, Mass., inquired whether Doctor Finney's patient showed any change in her blood sugar after the operation.

Doctor Finney replied that the blood sugar has been much more stable. There has not been such a wide variation, and it has been on the whole considerably higher but not very markedly.

Dr. WALTER E. SISTRUNK, Rochester, Minn. (in closing), approved the work of Doctor Stone in substituting a piece of small intestine for the large intestine, a procedure that offers possibilities which might be carried for a considerable distance. He had often wanted to do it but up to the present time has never had the nerve to attempt it.

Gross soiling in an intraperitoneal operation is certainly a dangerous thing. A small amount of soiling he had his doubts about. Every time one takes out appendix there is soiling. The peritoneum can handle a certain amount of soiling provided that it is not gross in character. For that reason he had never paid very much attention to an aseptic anastamosis, but he had tried always to be as careful as he could as far as gross soiling was concerned, and hoped that the peritoneum would take care of the remainder.

In his opinion, from considerable experience with it, the infections which produce fatal peritonitis come from the virulent organisms in the bowel wall and from the tissues surrounding growths. A good many years ago, before we had means of dealing with ulcerative colitis in a medical way as we have to-day, it was common in the clinic where he worked to do an enterostomy for ulcerative colitis, and in the first cases done the mortality was very high, somewhere in the neighborhood of 20 per cent. These cases were operated upon first by an exploration in which the bowel was palpated and often lifted up to look at, and the enterostomy was made by a method in which the ileum was cut completely across. The patients did very nicely for about forty-eight hours, and then a certain percentage of them went into a fulminating type of peritonitis and died. After thinking the matter over he decided that the exploration was the thing which was killing them. The trauma to the bowel caused an exudate from the peritoneal surfaces which carried with it virulent organisms.

He stopped the procedure absolutely in so far as exploration was concerned, and went in on the diagnosis which was made from the history, X-ray findings, and from the proctoscopic examination, and did an enterostomy of the same type under local anæsthesia. The mortality dropped from something like 20 per cent. down to considerably below 5 per cent. Then he felt quite sure that they had traumatized this bowel and had an exudate of virulent organisms and that that was the thing which caused the peritonitis.

Shortly after that, Dr. John W. Draper, of New York, was discussing with him the possibility of sterilizing the colon for operation by injection of aniline dyes. He said we can inject these dyes, leave them in for thirty or forty minutes before operation, and we can really sterilize that bowel, and the pathologist is unable to grow bacteria upon it. When you operate, that dye will come through the bowel wall. If you traumatize it or rub it you will find the dye on your sponges. That absolutely corroborated what they had learned clinically.

So he had felt that the virulence of those organisms had more to do with the fatal peritonitis than any slight soiling which might come and which probably happens in every appendectomy which is done.

Personally, while it looks as though a number of procedures are necessary in using an operation of this sort, one must consider that operations for resection of the colon are certainly dangerous operations and carry probably a mortality which is as high as any of the intraabdominal work which is done. Any factor that we can use which would tend to diminish mortality should be used. The question as to whether or not we delay a patient two weeks or two and a half weeks, or whether we do three operations instead of one, is to be very gravely considered, because if we try to clean everything up at one operation and get through, the mortality is certainly going to be very much higher than it is if the intestine can be placed at rest by a colostomy which stops all bowel movements, and by allowing a period of two and a half weeks before attempting a radical procedure.

INTRATHORACIC DERMOIDS

WITH THE REPORT OF A CASE OF TOTAL EXTIRPATION AT ONE SITTING
BY A NEW METHOD OF THORACOTOMY

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A REVIEW OF THE LITERATURE OF THORACIC DERMOID TUMORS

In an exhaustive study of the literature, 138 cases of thoracic dermoid tumors have been collected and herein summarized, including the author's case. This number of reports is greater than recent writers have reported. The majority of these growths were intrathoracic, and a few bulged into the neck; seven were found in the thoracic wall. Many of the case reports are incomplete and sixteen of them consist only of brief necropsy findings.

Etiology.—The genesis of these growths has not been definitely proven, although numerous hypotheses have been advanced. Ewing states that a single origin through a one-sided development of teratomata cannot be excluded for the entire group. The most generally accepted view seems to be that these dermoids are the result of fetal inclusions, the teratoma representing an early cell inclusion and the simple dermoid a later stage in the germinal differentiation. Some authors state that these tumors arise from ectodermal displacements pulled down into the chest by the descent of the heart or by some abnormal displacement of cells from one or the other of the branchial clefts. Another conception is that a blastomere is displaced in the course of development, and upon the development of this displaced cell depends the type of tumor which results.

Wilms concludes that dermoids of the head, chest and many of those of the retroperitoneal tissue are produced by abnormal development of germinal tissue with invagination of the epithelium to form glands, or by a growth of fetal fission cells; and he regards the intra-abdominal teratoma as a fetus in feto.

Presternal dermoids may result from imperfect closure of the anterior chest wall. Bergmann observed a dermoid divided into two compartments by the sternum but joined by a canal through the bone. In Bird's case a projection of the tumor dipped down between the manubrium and gladiolus sterni. A traumatic origin is unlikely though it has been demonstrated for both dermoids and epidermoids in many regions. From the varied pathology and location of these tumors, it is probable that a single origin would not apply to the entire group.

The infrequency with which thoracic dermoids are encountered is indicated by the number of case reports from that of Gordon's in 1825 to the present. Undoubtedly some cases have either been overlooked or not reported.

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Certainly many symptomless intrathoracic tumors, probably dermoids, are discovered in routine X-ray examinations of the chest and are not reported in the literature. One of us has seen at least a half a dozen such cases. Generally speaking and in order of frequency these neoplasms occur in the ovary, testicle, sacro-coccygeal region and mediastinum.

All authors have found that the greater number of cases have been observed between the ages of twenty to thirty years. The youngest cases are in infants. Medoei reported a cyst in a suckling; Medvel noted a cyst in a nursling; and Cahen observed a cyst in an eight months' old child. The oldest case was that of a cyst in a woman sixty-two years of age, reported by Fawcett.

The sex has apparently no influence and was about equally divided. There were fifty-nine reported in males, sixty-two in females, and in seventeen the sex was not stated.

Age	No. of cases	Sex			Type of tumor		
		M.	F.	?	Cyst	Teratoma	?
Under 1 yr	3			3	3		
1–10 yrs	8	3	5		5	3 (1 mal.)	
10–20 yrs	26	11	15		14	11 (2 mal.)	1
20–30 yrs	43	20	21	2	37 (1 mal.)	6 (1 mal.)	
30–40 yrs	23	10	13		21	2 (2 mal.)	
40–50 yrs	7	5	2		5	2 (1 mal.)	
50–60 yrs	6	3	3		5		1
Over 60 yrs	4	2	2		4		
Unknown	18	5	1	12	11 (1 mal.)	6 (3 mal.)	1
	138	59	62	17	105 (2 mal.)	30 (10 mal.)	3

In only eighteen cases was the occupation noted and these were of the middle and lower walks of life. Of the total 138 cases studied fifty-three were German, twenty-six American, nineteen English, fourteen French, eleven Russian, six Italian, one Swede, one Armenian, one Hindu, one Belgian, and five unknown.

Symptomatology.—There is no characteristic symptom complex of this disease as the symptoms are those which may accompany many intrathoracic affections. The only pathognomonic symptom is that of coughing up hairs. The disease usually can be divided into a latent and active period of variable duration. Occasionally one or the other of these stages may be missing. In other words the latent period, during which the growth gives no evidence of its existence, may continue throughout life and the tumor be accidentally found at autopsy. Again, the active stage, during which symptoms are present, may begin early in life and even at birth. The onset and course of the disease varies and were first divided by Dangschat into three groups: 1. Most frequently, the onset is insidious with a gradual increase in the severity of the symptoms. 2. The beginning may be similar but later followed by sudden development of severe and sometimes fatal symptoms. 3. Least

often, the onset may be acute with great severity and the further course of the disease terminate early and fatally or assume a chronic character. Alternating periods of remission and exacerbation of symptoms have occasionally occurred.

The ages at which symptoms began are tabulated as follows:

At birth	1–10	10–20	20–30	30–40	40–50	50–60	60–	Unknown
5	9	28	27	13	4	3	1	48

The onset in twenty-two cases was marked by some disease, injury or operation. Some writers claim that puberty usually denoted the beginning of symptoms, for the tumor at this time takes on a sudden rapid development. This may be true in a few instances but it is certainly not the rule as proven by the above table. The onset followed pneumonia in five cases, pleurisy in five, trauma in four, influenza in one, catarrhal infection in one, scarlet fever in one, typhoid fever in one, labor in one, weaning a child one, and an abortion in one.
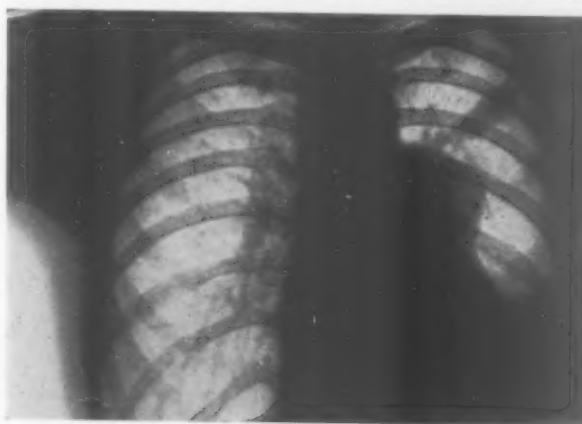

Fig. 1.—X-ray of chest taken September 18, 1924, when the tumor was first discovered.

The most common initial symptoms and signs present were sense of pressure or pain, localized or referred, (thirty-eight cases), cough with expectoration (thirty cases), and dyspnœa (twenty-eight cases). These three were frequently associated together at the onset. Other less common initial symptoms were; tumor of the neck in eight cases, hæmoptysis in four, tumor over the sternum in six, pleural effusion in four, fever in four, fatigue in two, coughing hair in one, fistula in the neck in one, abscess of the back in one, bulging of the chest in two, dysphagia in one, cyanosis in one, hoarseness in one, asthmatic attacks in one, vomiting in one, chills in one, cardiac palpation in one, defective vision in one, coryza in one, and the fact that the left shoulder was higher than the right in one.

Hertzler divides the symptoms into two groups, those due to 1, pressure; 2, irritation from the tumor. He suggests that the irritation is caused by some chemical changes of the increasing amount of the cyst contents, and in this way these growths may imitate the life history of wens. Such irritative symptoms as pleurisy, pleural exudates, pneumonitis, etc., may give rise to incorrect diagnoses.

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In forty-three cases the symptoms were not given. Dyspnœa, cough and pain were also the most common persistent symptoms. Dyspnœa occurred in fifty-nine cases and varied in severity. Usually it became more intense with the growth of the tumor, though occasionally it was paroxysmal, or severe at the onset, or marked by remissions of normal breathing.

Cough was noted in fifty-five cases, forty-three with expectoration, five without and unstated in seven cases. This like the dyspnœa was sometimes paroxysmal. The quantity of the expectorated matter in six instances was noted as copious. The quantity may increase with the course of the disease and sudden increase of the amount may denote rupture of the cyst into a
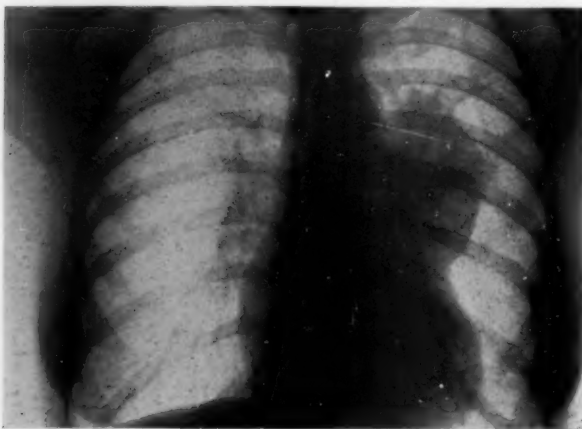

FIG. 2.—X-ray of chest taken May 11, 1925, showing the gradual increasing size of the tumor.

bronchus or lung. The character of the sputum was muco-purulent in five cases and of a dark brownish color in three. Hæmoptysis was present in nineteen instances and varied in amount. Occasionally it was so severe as to cause exitus. The cough produced pain in the chest in one case. Hair was present in the sputum in twelve instances. Its presence means a communication between the cyst and a bronchus or lung. Such communication was found at autopsy sixteen times and the absence of this symptom in the remaining four cases may be explained by the fact that the hair was rolled into a ball-like mass that was too large to pass through the opening. In six cases the odor of the sputum was foul and might lead one to suspect bronchiectasis or pulmonary abscess.

Pain was present in fifty-one cases. It usually was described as a dull ache or sense of pressure or tightness in the chest and occasionally it was sharp, severe or acute. It also may be paroxysmal. In one case it was distinctly worse at night. In fourteen of these reports the pain was referred to the location of the tumor, intercostal region, shoulder, back, ear, back of the head, infra-clavicular region, abdomen, or arm of the affected side.

Fever occurred in twenty-one cases and was of a low grade type unless there was some complication or intercurrent disease.

Other symptoms were: Cyanosis seventeen cases, elevated pulse sixteen, rapid respiratory rate eleven, chills five, dysphagia four, vomiting three, headache four, œdema of the feet eight, ascites two, general anasarca one, night sweats two, diaphoresis one, palpitation four, orthopnœa one, coryza one, abdominal pain one, fistula in the neck one (Bastianelli), fistula in the

chest four (Koerte, Bergmann, Belin, Goebel and Ossig), clubbing of the fingers five (Godlee, Ekehorn, Whittemore, Fawcett, Shaw and Williams), clubbing of the toes one (Fawcett), hoarseness or changing voice three (Griffin, H. Smith, Morone), impairment of speech one (Black and Black), numbness of the right hand one (Shostak), and defective vision of the left eye one (French).

Findings on Examination.—No examination was made or no findings reported in fifty-four cases and examination of the patient was negative in four instances. The findings noted were mainly the unusual ones: Emaciation or cachexia in seventeen cases, distention of the superficial veins in ten, inequality of the radial pulse in two (Cordes, Becker and Carey), unequal pupils in five (Marfan, Kraus, Murphy, French, Smith and Stone), ptosis of the left eyelid in two (Murphy and French), laryngeal changes in one (Kraus), left vocal cord paralysis in one (H. Smith), œdema of the nearest arm in two (Ceelen, Becker and Carey), scoliosis in four
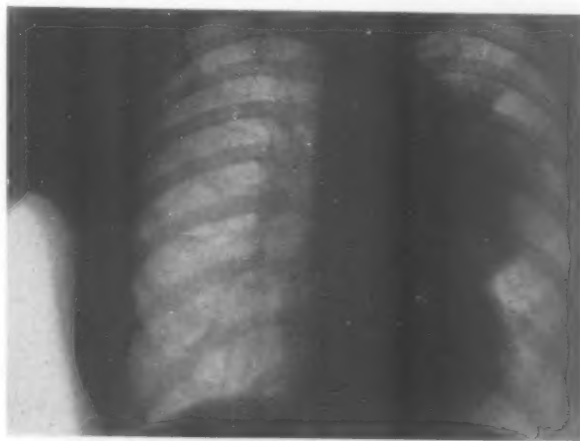

Fig. 3.—X-ray of chest, September 7, 1926, when the tumor had almost reached the lateral chest wall and first showed lobulation.

(Murphy, Nandrot, Von Torok, Payr), and kyphosis in one (Payr). Murphy's patient in addition to unequal pupils, ptosis of the left eyelid, distention of the superficial veins, and curvature of the cervical spine to the left also presented a spastic ataxic gait, choreoform jerkings and decreased motor power of the left arm, rigidity of the neck and sensory disturbances. French reports that the individual could not blush and did not perspire on the left side of the face in addition to having ptosis of the left eyelid, a smaller left pupil and distention of the superficial veins. Becker and Carey noted tenderness over the sternum and œdema of the left side of the face besides œdema of the left arm, distention of the superficial veins and inequality of the radial pulses. Enlarged lymphatic glands were observed in the neck in two instances (Griffin, Edelman), in the axilla in one (Griffin), and in the supra-clavicular region in one (Cahen). Two of these cases presented malignant degeneration of the tumor.

A swelling or bulging of one side of the neck was seen in fourteen cases, seven of which were fluctuant and three transmitted a pulsation but this was never expansile. Pohn reported a bilateral tumor of the neck and Hertzler a midline tumor above the sternum. A unilateral bulging or fullness of the chest was mentioned in thirty-seven reports; three of which were fluctuant

(Mandelbaum, Von Torok, Kleinschmidt). A tumor over the sternum was present seven times (Selby, MacEwen, Clutton, Cahen, Calvalcanti, Morestini, Bird); three of these fluctuated. In two cases there was a sinus in the chest and in another in the neck (Morestini).

Palpation revealed a diminished expansion of the affected side of the chest thirteen times and decreased or absent tactile fremitus over the growth eighteen times.

By percussion over the tumor there was relative or absolute dullness noted in fifty-four instances.

Auscultation over the growth gave distant or absent breath sounds in forty-one cases, decreased or absent voice sounds in fourteen, a friction rub in two, increased voice sounds in one, tubular or bronchial breathing in six, and moist or dry râles in eighteen. The physical signs of a cavity due to emptying a perforated cyst have never been observed.

The heart was displaced to the left in fifteen instances, to the right in eleven, and downward in one. Pericardial effusion was present in two cases (Cordes, Kavanagh).

The liver was displaced downward in fourteen instances; the tumor being in the right hemi-thorax.

Röntgenological Studies.—X-ray or fluoroscopic examination was made and of diagnostic value in thirty-five patients. In Morone's patient it was reported negative. Hale noted pulsation of the tumor on fluoroscopy but this case was later studied and operated by Lilienthal who could not confirm the finding. The neoplasm usually gave a definitely outlined shadow but sometimes its shadow was continuous with that of the heart. To demonstrate teeth or pieces of bone in the growth is possible and practically diagnostic. Bone was shown in this way in Smith and Stone's patient and calcified deposits seen by Kleinschmidt and Goebel and Ossig. None of the röntgenologic studies report infiltration of the surrounding lung or mediastinal structures. A pneumo-peritoneum with carbon dioxide gas was performed by Moons to exclude any abdominal origin of the tumor. Examination following intra-tracheal injection of lipoidal has never been reported except in the author's case. It is of value in determining the degree of pressure on the bronchi and the possible presence of a communication with a bronchus.

Bronchoscopy.—A bronchoscopic examination was made in three cases (Lilienthal, Hamman, H. Smith), and apparently was of diagnostic assistance in the last case. It might help inform one of the location of the growth or of the degree of pressure or irritation of the bronchial tree. The possibility of emptying a communicating cyst by this method has never been reported.

Laboratory Studies.—Of these, microscopic examination of the sputum and of the fluid obtained by aspiration of the tumor are most important. The former aided in the diagnosis in four cases, excluding the gross presence of hair in twelve and blood in nineteen instances. Epithelial cells, especially those resembling the horny layer of the skin, fat droplets and cholestrin crystals were found in the expectorated material. In a few cases smears were

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made to rule out other infectious lung diseases. In forty-three cases aspiration of the tumor was attempted and examination of the obtained material of value in nineteen. Culture of this fluid was negative in six instances. The gross and microscopic findings of aspirated material are similar to those sometimes found in the sputum. Blood studies are of no direct diagnostic assistance except in the presence of some complication or malignant degeneration of the tumor. Whittemore reported a leucocytosis and French an eosinophilia.

Morbid Anatomy.—The various names applied to these neoplasms designate their pathologic structure: dermoid, epidermoid, teratoma, embryoma, fetus in feto. We have divided them into (1) dermoid, (2) teratoma. The dermoid cyst consists of skin and its appendages and sometimes cartilage, bone and teeth. In this group are included the epidermoid tumors in which definite dermal structures are wanting. The teratoma contain derivatives of all three germ layers, ectoderm, mesoderm, and entoderm. The true embryoma and fetus in feto should closely resemble an embryo or rudimentary fetus and strictly speaking

FIG. 4.—X-ray of chest taken March 14, 1927, after an injection of lipiodal. In the plate the angulation and constriction of the left bronchus can be seen.

these have not been reported in the thoracic cavity. However, Prym reports in an eleven-year-old girl a "dermoid cyst" of the anterior mediastinum which, in a solid part, contained maxilla-like formation with teeth. The histological examination revealed different components which, as a whole, correspond to the cephalic pole of an individual.

There were 105 dermoid cysts, thirty teratomata, and three tumors of undermined pathology. Sixty-four autopsies were reported and ten deaths without autopsies besides the total or partial specimens examined after operative removal.

Located in the anterior mediastinum were forty-three tumors, in the posterior mediastinum one (Foa), in the right hemi-thorax forty-seven, in the left forty, directly behind the sternum ten, in front of the sternum seven, at the bifurcation of the trachea one (Ceelen), in the right lung two, in the left one, on the pulmonary artery within the pericardium one (Joel). In three cases the location was not stated. Naturally many of the tumors reported in the anterior mediastinum also extended into one or the other side of the

thoracic cavity. The greater majority of these tumors evidently originated in the anterior mediastinum and extended into either side of the thorax from some unknown cause, possibly the forces the surrounding structures exerted upon the tumor or the fact that one portion of the growth developed more rapidly.

The size, weight, shape, color and consistency of these neoplasms vary markedly. The size ranged from that of a walnut and pigeon egg to those which fill one side of the thorax. Some were accurately measured, in others the cyst contents were measured, and in many various descriptive terms, such as a child's head, cantaloupe, grapefruit, man's fist, apple, cocoanut, tangerine, goose egg, hen's egg, etc., were used. In Foucher's case the cyst contained 2 to 3 litres and in Schlier's four quarts. The size of the growth should be considered with that of the individual for comparatively enormous tumors have been reported in children. Of the few recorded weights the heaviest was 4750 gms. (Christian) and the next 4300 gms. (Becker and Carey).

FIG. 5.—X-ray of chest taken June 25, 1927. Eleven days after operation, showing the complete pneumothorax.

The shape has been described as globular, spherical or round, lobulated, nodular, uneven, etc. In a very few the color was given as gray, white, pink or combinations of these. One was described as gray with pink and red areas. Though the wall of the cystic tumors is opaque, the color sometimes might depend upon its contents or hæmorrhage into the cyst. The consistency was not mentioned but varies with the type of tumor and its contents.

There were sixty-nine single cysts, thirty-four multilocular and eight multiple ones. In the remaining twenty-seven cases this was not stated or the tumor was solid. Often a single cyst contained a solid portion in its wall.

The neoplasm was practically always adherent to the neighboring tissues which may be any structure within the chest. Seldom is it fastened to but one structure. Adhesions to cervical tissues are quite common when the growth has extended upward into the neck. The nature of the adhesions vary from thin, filmy or fibrinous ones which are easily separated to very firm, fibrous ones where no definite line of demarcation can be made out. In Mouat's case the cyst consisted of two parts extending from the thyroid to the diaphragm and partly divided by a band. The cyst wall inseparably

blended with the pericardium. The upper part of the cyst was the size of an orange, irregular and its projections pressed upon the innominate vein and artery, vena cava, aorta, pulmonary vessels, left carotid artery, thymus, trachea, vagus, and phrenic nerves. The character of these adhesions does not so much depend upon the size of the tumor, but rather upon the irritation of the neighboring tissues produced by the tumor. The growth was adherent to the lung in fifty-nine cases, the pericardium in forty-two, chest wall in thirty-two, diaphragm in eighteen, the great vessels in twenty-one, trachea in seven, thymus in six, œsophagus in three, thyroid in two, vertebræ in one, and the vessels in the neck in one. Joel reports a teratoma attached to the pulmonary artery within the pericardium but the lumen of the artery was patent.

Most uncommonly a cyst may perforate a bronchus or lung and totally or partially empty its contents. A communication with a bronchus was observed in fourteen cases and with a lung in four. The tumor had perforated the skin once (Koerte), the aorta once (Buchner), and the pericardium twice (Cordes, Perves and Oudard).

FIG. 6.—X-ray of chest taken August 1, 1927, about six weeks after operation, showing the beginning expansion of the lung.

In Korner's case the growth had eroded the sternum until there was an opening the size of a lead pencil through the bone.

In a few instances the lung was so pressed into one portion of the thorax that it had atrophied or become atelectatic. Whittemore states the right lung was pushed into the apex of the chest and its appearance so changed that its identity was assured only by recognizing the lobes. It would not expand after the removal of the tumor. McArthur and Hollister also report atelectasis of the lung from neoplasmic pressure.

Many kinds of tissue and semi-liquid material were found in the contents of these dermoids. Hair was reported eighty-four times and the absence of hair mentioned eight times. The hair was sometimes attached to the inner lining of the cyst, or on polypoid masses, or found singly, or in balls or masses of different shapes embedded in the cheesy contents. The color of the hair usually did not correspond to that of the individual and occasionally was very fine and downy. Sebaceous or fatty material occurred in seventy-nine cases, pus in ten, myxomatous fluid in two (Whittemore, Smith and Stone), gelatinous fluid in two (Carpenter, Joel), colloid material in one
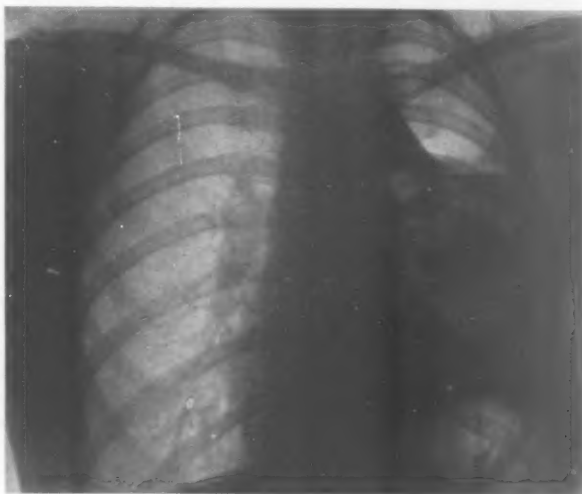
(Christian, 1907), serous fluid in one, and a mucoid substance with brown grains in one (Lilienthal). Mixed in with these liquid and semi-liquid substances were epithelial cells usually of the stratified pavement variety in thirty-three cases, cholestrin crystals in twelve, red blood cells in five, and frequently fat droplets. Striated muscle tissue was present in the contents in two instances, lymphatic tissue in two, and a portion of spleen and intestinal wall in one (Pohl). Pieces of bone occurred fifteen times, cartilage seventeen, and teeth eight. These latter structures were often associated together though not always. The bone and cartilage assumed irregular shapes though in Gordon's case the bone resembled an upper maxilla and Prym found a maxilla-like formation with teeth. The number of teeth varied from one to seven; Bergmann found four and Gordon reported seven. The shape or kinds of teeth were not stated. The contents of these tumors also showed calcareous or calcified material five times, atheromatous four, and concrements twice. Polypoid projections covered with epithelium were found in twenty-four instances and occasionally grew hairs. The polyps sometimes were so numerous as to fill the cystic cavity and when removed gave rise to serious hæmorrhage or recurred.

FIG. 7.—X-ray of chest taken October 21. 1927, showing the lung almost completely expanded and the diaphragm descending.

The wall of these growths varied considerably in thickness and structure. The thickness of the wall was not usually uniform. Nandrot reports one of 3 mm. thick, Beye one of 1 cm., and Caldbick one of 3 to 6 cm. The structure of the wall often showed the same variety of tissue as found in the contents. Epithelium resembling skin or mucous membrane was present in sixty-four cases, ciliated in fourteen, glandular in six, intestinal in four, retinal in two, liver in two, and thyroid epithelium in one. The absence of epithelium was mentioned by Marfan. Hair follicles were reported nineteen times, sebaceous glands twenty-seven, sudoriferous glands twenty-one, mucous glands four, salivary gland tissue two, connective tissue ten, nerve or ganglion cells sixteen, lymphoid tissue seven, smooth muscle eighteen, striated muscle eight, fat tissue three, colloid material two, blood cells six, free blood two and pancreatic tissue one. The tumor wall also contained cartilage in twenty-three instances, bone in fourteen, teeth in two, and calcareous or calcified areas in seven. Sieber found derivative organs of the intestinal tract and Payr's case showed a section of large intestinal wall.

Secondary changes in the neoplasms are not uncommon and include papillary ingrowths, overgrowths or dermal structures, rupture, suppuration, and malignant changes. These except the last have been previously mentioned. Malignant degeneration was found in twelve cases (ten teratomata and two cysts). Sarcomatous changes occurred in seven, carcinomatous in six, and chorio-epitheliomatous degeneration in one (Ritchie). The cases of Virchow and Warthin presented both sarcoma and carcinoma. Chorio-epithelioma development in teratomata is seen most frequently in the testicle (Warthin, Frank). There were metastases in the liver in five of the twelve cases, in the lungs in three, pleura in one, sternum in one, ribs in one, spleen in one, mediastinal lymph glands in two, supra- and infra-clavicular glands in one, and axillary glands in one. The type of metastases was mentioned in five reports and was identical with that of the original tumor.

Adenopathy of the mediastinal lymph-nodes reported in three instances was due to malignancy twice and infection once.

FIG. 8.—X-ray of chest taken on April 3, 1928, showing the complete disappearance of the pneumothorax, descension of the diaphragm and the beginning of the lung shadow.

Intercurrent Diseases and complications.—A great variety of conditions were reported, some of which caused exitus. The most common were perforation of the cyst, pneumonia, and pleural effusion. Perforation as heretofore mentioned was present in twenty-three instances. Lobar or broncho-pneumonia occurred in eleven cases and in one of these peritonitis was associated. Pleural effusion was present eleven times, the fluid was usually yellowish but hemorrhagic twice. Malignant disease developed in twelve cases. Pulmonary tuberculosis was given in nine instances and in another tuberculous peritonitis and enteritis occurred (Marfan). The other complications reported were empyema five times, secondary post-operative hemorrhage five, post-operative febrile reaction three, pericardial effusion two (Cordes, Pohl), pericarditis two (Christian, Goebel and Ossig), bronchiectasis two, one was bilateral (Sormani, Ekehorn), pneumothorax one (Turk), hydro-pneumothorax two (Kavanagh, author's case), infection of the cyst three (Payr, Davies, McArthur and Hollister), pyemia one (Godlee), sepsis one (Smith and Stone), toxemia one (Mandelbaum), ascites (Mouat), cardiac enlargement with thrombosis of the left subclavian and left internal jugular vein (Ceelen).

Diagnosis.—The diagnosis is not easy and many cases were mistaken for other conditions before operation or exploratory puncture. The entire picture of the disease must be taken into account, for the variation of the symptoms, signs, and behavior of the tumors, and the presence of intercurrent diseases or complications offer many diagnostic difficulties. Expectorating hair is pathognomonic and the definite signs of a solid intrathoracic mass should arouse one's suspicion. Examination of the sputum, X-ray and fluoroscopic study, bronchoscopy, and the ineffectiveness of treatment other than surgical may sometimes be of considerable assistance. Exploratory puncture is valuable. This was done in forty-three cases and in nineteen of these examination of the aspirated fluid was of diagnostic aid. The important findings in this fluid and in the sputum have already been referred to. Puncture of the tumor should be done with a long needle of wide lumen or a trocar attached to an aspirating apparatus. Fluoroscopy is an ideal guide in this procedure. In some instances diagnostic incision is necessary and should be done if there is sufficient indication.

Fig. 9.—Photograph taken ten days after operation, exhibiting the incision. No dressing or support was necessary and post-operative calisthenics were instituted at this time.

The many problems of differential diagnosis will not be discussed at length except to mention some of the mistaken impressions that were reported. An incorrect diagnosis of empyema was made seven times, pleurisy four, pleural effusion three, pneumonia three, hydatid cyst three, pulmonary tuberculosis two, tuberculous mediastinal adenitis one, central abscess of the chest one, lung abscess one, bronchiectasis one, aneurism one, caries of the rib one, goitre one, asthma one, cold abscess one, actinomycosis one, streptothricosis one, and atheroma one.

Other conditions which might cause confusion are: benign tumors as lipoma and fibroma, persistent enlarged thymus, malignant disease, pericardial effusion, syphilis, and lung calculi.

Duration.—The duration of the condition more commonly lasts from two to five years. In five cases it existed practically throughout the lifetime of

the individual (eleven, seventeen, twenty-two, twenty-four, and twenty-nine years). The longest duration was forty-five years.

Duration	1–4 wks.	1–3 mos.	3–6 mos.	½–1 yr.	1–2 yrs.	2–5 yrs.	5–10 yrs.	10–20 yrs.	Over 20 yrs.	45 yrs.	Un-known
No. of cases........	7	7	1	11	10	24	17	6	3	1	51

Prognosis.—The outlook depends upon many factors; the size, location, rapidity of growth of the tumor, the number and severity of symptoms present, the general health or physical condition of the individual, and the possibility of complete extirpation of the tumor. In the majority of cases the patient's life is sooner or later endangered unless the tumor is removed or its development curtailed. In a few instances the individual has suffered but few or no symptoms for many years and death was due to some other cause. The cause of death in either operated or unoperated cases has been one of the above-mentioned complications.

Treatment.—The treatment is surgical. Medical, anti-syphilitic, and X-ray or radium therapy are useless except occasionally as a means of differential

Fig. 10.—Photograph of the tumor, showing the collapse of the more recent lobule of the cyst into which is seen the projecting finger-like process covered with fine hair and normal skin.

diagnosis. Kahn's case was given seven radium treatments without results and later operated upon. The first case to be operated was in 1871 when Pohn incised and drained a dermoid protruding in the neck. The ultimate result was not stated. Complete extirpation was first performed in 1893 by Bastianelli who resected the manubrium after three previous excisions of a fistula. A permanent cure followed. The type of operation and method of approach are determined by the size and location of the neoplasm and its adherency to neighboring structures.

Operation should be recommended in the majority of cases, but not in all, for in a few the tumor has remained dormant without symptoms throughout lifetime. Such cases have been reported on finding the growth at

FIG. 11.—A new method of thoracotomy showing bevelled incision of the sternum into the first and sixth interspaces, allowing the left half of the sternum with the ribs to be sprung open in the form of a trap door which gives complete access to the entire hemithorax. The thoracotomy gives ideal exposure for any intrathoracic manipulation as it exposes the mediastinum, pericardium and hylus of the lung.

necropsy. These latent tumors might be accidentally picked up by routine examination or X-ray and it is unwise to submit these individuals to the risks of thoracotomy.

The palliative surgical procedures are aspiration, incision and drainage with or without partial removal, and decompression. Obviously the only curative procedure is complete extirpation. Aspiration was done in forty-three cases mostly for diagnostic purposes, but gave partial relief of symptoms in seven instances. As much as 400 c.c. and 700 c.c. have been withdrawn (Caldbick). Becker and Carey aspirated 3 litres and Carpenter 13½ ounces of pleural fluid with relief. Decompression alone was not reported. Senn made an opening through the sternum but did not find the tumor. This opening however was not of sufficient size to decompress the tumor. The following table denotes the type of operation, number of sittings and results reported:

	Incision and drainage	Complete extirpation	Totals	
1 stage oper.	28	17	45	
2 stage oper.	9	8	17	
3 stage oper.	4	2	6	
4 stage oper.	0	3	3	73
10 stage oper.	1 (Shaw, relieved)	0	1	
17 stage oper.	0	1 (Davies, cured)	1	
Cured	0	28	28	
Relieved	20	0	20	
Unchanged	1 (Senn)	0	1	
Result unstated	2 (Pohn, Koenig)	0	2	
Deaths	19	3	22	

Local anæsthesia was reported used six times and general fourteen. Whittemore attempted paravertebral injection in vain. Morris advises the use of chloroform in preference to ether because of the constant and prolonged bronchitis frequently associated with these tumors. A local anæsthetic might be used in a few instances where the growth is easily accessible. A general anæsthesia of gas and ether is preferable in the majority of cases when the thorax and possibly the pleura are opened, for during closure, if drainage is not indicated, the lung can be insufflated and restored as nearly as possible to normal function.

The cystic tumor or resulting cavity after removal was drained in forty-eight cases, the pleura in three, and the pericardium in none. In but two cases was it definitely stated that drainage was not employed. The cyst ruptured during operation in five instances (Naegeli, Selby, MacEwen, Bird, author's case).

The length of time between the first and final sitting varied from four days to five years. In twelve cases this interval was within a year, in five cases within two years and in Madelung's patient five years for two stages. Davies reported a cure after seventeen sittings within two years.

Several operators have attempted the use of chemicals to destroy the cyst

lining. Lilienthal tried a solution of 10 parts zinc chloride, 10 parts copper sulphate and 80 parts water with resulting pain and febrile reaction. In Shaw's patient an ethereal soap solution and the cautery were used. Schleier tried cauterization with 20 per cent. silver nitrate but reports almost entire destruction of the cyst wall by recurrent collection of pus over a period of two years. Irrigation of normal salt solution, Dakin's Solution, Borio-Salicylic (Thiersch's) solution, etc., have been used. Such treatment is dangerous in the presence of bronchial fistula.

The method of approach was not stated in eleven instances. Rib resection was employed thirty-seven times and partial resection of the sternum with ribs three (Koerte, Bergmann, Davies). Sometimes a flap was made of the soft tissues of the chest wall and beneath this a portion of several ribs removed. For example, Caldbick reflected a flap of the left breast and pectoral muscles and then resected a portion of two ribs. Secondary operation was often done through the previously made opening in the chest. A simple incision over the tumor was used in eleven cases. In these the growths were anterior to the sternum or in the neck where a goitre incision was mentioned twice. An opening was trephined or chiselled through the sternum five times (Kuckman, Koenig, Pflanz, Senn, Doenitz). Kavanagh reports resection of the right half of the sternum. Bastianelli resected the manubrium while Morestini folded it to the right and bisected the tumor. Moons made a flap of the right breast with the third, fourth, fifth, and sixth ribs. The author's approach is original and might be applied to other surgical intrathoracic lesions.

Complete extirpation at one sitting was reported in seventeen cases. In nine of these, the tumor was in front of the sternum or protruding in the neck and required but simple excision. All were cured. There are only eight reported intrathoracic dermoids totally removed at one stage (Caldbick, Turk, Whittemore, Naegeli, Kleinschmidt, Smith and Stone, Duval and Clerc, and the author's case). Rib resection was employed in all except in the last instance. Seven were cured. Smith and Stone's patient died five months later of sepsis.

The only death at operation was from suffocation (Spath). Between twenty-eight hours and three weeks' post-operative there were thirteen deaths, three due to pneumonia (Mandelbaum, Von Torok, Kahn), three to hæmorrhage (Koerte, Dangschat, Rautenberg), one to dyspnœa (Doenitz), one to fibrinous staphylococcic pericarditis (Goebel and Ossig), one to rupture of the cyst into the pericardium (Perves and Oudard), and four to unknown causes (Shostak, Nandrot, Masson, Sieber). From two and one-half months to five years after operation seven deaths were reported due to pyemia (Godlee), sepsis (Smith and Stone), hæmorrhage (Black and Black), rapid growth of the tumor (Griffin), Hodgkin's Disease (McArthur and Hollister), and unknown causes (Madelung, Christian). Pohl neither mentioned the time nor cause of exitus.

INTRATHORACIC DERMOIDS

CASE REPORT.—Mrs. E. C. J. consulted us March 9, 1927, complaining of: Constant hacking cough; soreness in the chest; sense of fulness in the left thorax; intermittent attacks of temperature, with pain in the chest.

Her family history was irrelevant. Her general health had been good up until six years ago when she had a severe attack of "Flu". Ever since then she has not felt well and has lost her usual energy.

Three years ago she had an attack of pleurisy accompanied by rather severe pain and soreness in the chest. She has become conscious of a sense of fulness in the left thorax. The hacking cough of which she complains began at this time. An X-ray disclosed a tumor in the left chest apparently arising from the mediastinum. After thorough study Doctor Groover made a diagnosis of mediastinal dermoid and advised repeated X-ray studies to watch the progress of the tumor.

During the past three years there have been many attacks of fever with increased cough and chest soreness. The expectoration has been slight in the interims, but increases during fever. She has never spit up any blood except on one occasion after a severe coughing spell. The attacks have gradually grown more frequent, the coughing more annoying and lately there has been dyspnœa on exertion. X-ray examination made frequently during the past three years shows a gradual enlargement of the tumor. In July, 1926, a bilobular development in the tumor could be made out. X-ray taken September, 1926, showed the tumor nearly reaching the lateral chest wall and occupying about one third of the left hemi-thorax.

On examination she was a healthy appearing woman of forty three years of age, of good color and weighing 121 pounds. There was a constant, hacking, non-productive cough. The general examination was essentially negative.

The left chest appeared fuller in front than the right, though there was no definite bulge. Respiratory expansion was good and equal on both sides. The cardiac dullness extended to the nipple line. There was relative dullness extending from the cardiac dullness to the first interspace. There was no dullness made out over the posterior surface of either lung. Auscultation revealed suppressed breath sounds over the dull area in front and in the left axilla towards its apex. Examination of the sputum showed no tubercle bacilli, there were numerous chains of streptococci, many fusiform bacilli. No spirocheta were seen.

X-ray studies made after the oral injection of lipiodol, showed the mass lying in the front of the left hemi-thorax against the anterior chest wall. A narrowing of the left bronchus with some angulation could be made out. The lipiodol was seen collected in large droplets below this constriction of the bronchus.

April 15, 1927, the mass was aspirated with a two and one-half c.c. hypodermic syringe and one c.c. of dirty fluid containing white flakes was withdrawn. The fluid contained fatty acids, but no crystals and no cellular elements. The patient believed that the aspiration had relieved the cough and had permitted her to sleep. It was, therefore, decided to try to collapse the cyst by aspiration. Under fluoroscopic guidance a large trocar was thrust into the centre of the tumor. On releasing the trocar it oscillated widely showing the intimate connection beween the tumor and the pericardium. A Potain aspirator withdrew only one half c.c. of blood-tinged fluid. This specimen revealed epithelial cells and confirmed the diagnosis of dermoid cyst.

Operation was advised and agreed to. It was planned to expose the cyst and remove it if possible. If this was impracticable, an attempt to marsupialize it was to be made and failing this to resect the thoracic cage overlying the tumor, and thus decompress the affected lung. After carefully considering all the methods of approach devised for intrathoracic surgery, it was decided to try a new incision that promised excellent exposure with minimum post-operative disturbance.

The essential idea is that of a trap-door. It differs from those previously used, in that the flap is larger, giving a more adequate exposure. The second to the sixth ribs and half of the sternum are included in the flap. The base of the flap is toward the

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side and roughly corresponds to the anterior axillary line. The elasticity of the ribs allows this flap to be raised and sprung laterally without costal fracture. This gives excellent exposure to the entire hemi-thorax.

The edge of the flap is formed by the bevelled incision of the sternum. Thus when the intrathoracic work is completed the trap-door can be closed, leaving the thoracic cage intact.

The operation was performed June 14, 1927. Under ethylene anæsthesia a vertical incision was made over the middle of the sternum. The manubrium sterni was trephined with a Doyen burr, as was the lower portion of the gladiolus sterni opposite the sixth interspace. The mediastinal contents were dissected away from the back of the sternum and a Gigli guide passed from one trephine hole to the other. The saw was passed and the sternum was split longitudinally bevelling the saw-cut sharply to the right. The two trephine openings were then connected to the first and sixth left interspaces with a DeVilbis bone cutting forceps. The anterior mammary vessels were found, ligated and divided. The skin and intercostal muscles of the first and sixth interspaces were cut midway between the ribs. On elevating the flap the reflection of the pleura from the mediastinum to the anterior chest wall was exposed and divided. The trap-door could then be sprung open exposing the entire left hemi-thoracic cavity. The tumor could be seen presenting behind the pleura. The upper lobe of the lung was adherent to the upper portion of the cyst. The pleura was stripped readily from the tumor. There was one band of adhesions from the outer aspect of the mass to the lateral chest wall. The cyst was dissected with the finger and shelled out readily, except for a firm adhesion to the pericardium which was divided with scissors. On attempting to strip the upper, outer portion of the tumor from the lung and chest wall, a portion of the cyst was opened and some cheesy material and hair escaped. The pedicle arose from the anterior mediastinal tissues where the vessels of supply to the tumor were clamped and divided. The entire dermoid was taken out of the chest with very little loss of blood. The débris was sponged out of the pleural cavity and the lung expanded by increasing the oxygen pressure to 20 milligrams of mercury. The trap-door was closed and held in place by two kangaroo sutures passed around the sternum, through the second and fifth interspaces. A number two chromic suture was passed around the sixth and seventh ribs close to the sternum and another around the second and through a drill hole in the first rib. This effectually held the bevelled incision of the sternum closed. The superficial fascia was closed with a continuous locked suture of number one plain catgut. The skin was sutured with silkworm gut. No drain was used. Dressings were applied and the left chest strapped with adhesive plaster.

Her immediate post-operative condition was very satisfactory. On the third day post-operative there was some cough, her temperature rose to 100, the pulse was 130 and respirations 30. Examination under the fluoroscope showed the left chest opaque with the heart somewhat displaced to the right. In the upright position the opacity cleared somewhat toward the apex demonstrating fluid. The left chest was therefore aspirated with a Potain apparatus and about 1200 c.c. of blood-tinged fluid withdrawn with a great deal of air. Culture of the fluid proved it sterile. Her convalescence proceeded satisfactorily. Eleven days after operation the chest was again aspirated and 450 c.c. of blood-tinged fluid was withdrawn, as well as a large amount of air. She was allowed to go home in an ambulance on the twelfth day.

X-ray studies five weeks post-operative revealed a complete pneumothorax of the left side with areas of adhesions extending from the collapsed lung to the periphery. There was a slight amount of fluid. The heart was not displaced.

Calisthenics were prescribed to overcome the tendency to scoliosis and she was directed to exercise her lung by blowing fluid from one bottle to another. Röntgenograms demonstrated the gradual expansion of the lung up to January 10, 1928, when the lung was found completely expanded. Another plate made April, 1928, shows an increase of expansion and a descent of the diaphragm with clearing of the lung shadow. She is

perfectly well, there is no cough, no pain in the chest and there has been no recurrence of the febrile attacks.

Pathological report of the tumor is as follows:

A grossly lobulated mass generally spherical in form and about 12 cm. in diameter. Some of the lobules contain yellowish fluid, firm cartilaginous substances, others sebaceous material. In some spaces within the lobules there is a definite lining with hairy membrane and beneath the lining membrane, typical fatty tissue. At several points small masses having almost a bony consistency are seen.

Microscopic section shows typical fatty tissues with a covering of stratified epithelium in which are found hair follicles and secreting gland acini. One section is especially rich in gland acini which except for their number are characteristic of the usual skin glands. Diagnosis dermoid cyst. (Multiple teratoma.)

SUMMARY

In a review of the literature 137 cases of thoracic dermoids have been collected and one reported. Of these, seven were located in the chest wall anterior to the sternum and the balance intrathoracic. A few of the mediastinal growths bulged into the neck. Sixteen reports consisted of only autopsy findings. These neoplasms are probably due to fetal inclusions. The greater number was found between the ages of twenty to thirty years. The onset of the disease was most frequently insidious and the course chronic.

In a number of instances the growth gave no symptoms and was only found accidentally at autopsy. The only characteristic symptom is coughing up hairs. The other common symptoms were dyspnœa, cough and pain. The principle signs were bulging or diminished expansion of the affected hemithorax, decreased or absent tactile fremitus, dulness and distant and absent breath sounds over the tumor. The heart and liver in some cases were displaced. X-ray showed a definitely outlined, non-pulsating mass. Examination of the sputum and material aspirated from the growth were important diagnostic aids. The pathology of the neoplasms varies from the simple dermoid containing dermal structures to the complicated teratoma which consists of derivatives of all three germ layers.

The principle complications were perforation of the cyst, pneumonia, pleural effusion and malignant degeneration. The diagnosis is made by the entire picture of the disease. The prognosis is grave unless the neoplasm is removed or its development curtailed. Palliative measures include aspiration, incision and drainage, and decompression.

Complete extirpation is the only cure. There were seventy-three cases operated; forty-five in one sitting and the balance principally in two- to four-stage procedures. There were twenty-eight cured, twenty relieved, twenty-two deaths, one unchanged and in two the result was not stated. Complete extirpation at one sitting of an intrathoracic dermoid has been reported only eight times with one death.

The method of approach was rib resection except in the author's case. In this instance under ethylene anæsthesia the sternum was split longitudinally with a bevelled edge and by dividing the intercostal muscles in the first and sixth interspaces a trap-door was sprung open with its base at the anterior

axillary line without costal fracture. This exposed the entire left hemi-thorax. The tumor was shelled out and the flap closed without drainage meanwhile expanding the lung. This method of thoracotomy is probably applicable to other intrathoracic lesions.

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RELATION OF ATELECTASIS TO OPERATIVE PNEUMONIA

DR. WALTER E. LEE, Philadelphia, read a paper with the above title, for which see ANNALS OF SURGERY, July, 1928, Vol. LXXXVIII, I. 6.

DISCUSSION: DR. CHARLES L. GIBSON, New York City, reported nine cases of massive collapse of the lung recently. The last two were subjected to a treatment which is a definite contribution to the etiology and the effective treatment of this condition. This is along the lines that Docor Lee has described, and he was inclined to think that it is going to call for much less use of the bronchoscope. The first case was a young man of twenty-one, who exhibited cough, temperature and increased respirations on the night following operation. Diagnosis was confirmed by X-ray on second post-operative day. The examination of the thorax showed marked opacity of the entire chest and quite marked deviation of the trachea, heart and mediastinum to the left side. The findings indicated a massive collapse.

The house surgeon placed the patient on the sound side, then slapped him smartly on the affected side, whereupon the patient immediately became very uncomfortable, gagged, struggled, got blue, looked as if he might choke to death, and finally got rid of a huge gob of mucus and was clinically

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relieved at once. The X-ray pictures taken thirty minutes afterward showed already the beginning of reæreation of the chest and the restoration to their normal positions of the cardiac shadow and the trachea.

The second case was a man whose symptoms developed at the end of the first twenty-four hours, and he was given the same treatment, after the X-ray had shown a massive collapse.

DR. KARL KORNBLUM, Philadelphia, Penna., said that his interest in post-operative atelectasis was from the standpoint of the röntgenologist. They had had occasion at the University Hospital in Philadelphia to examine a great many ca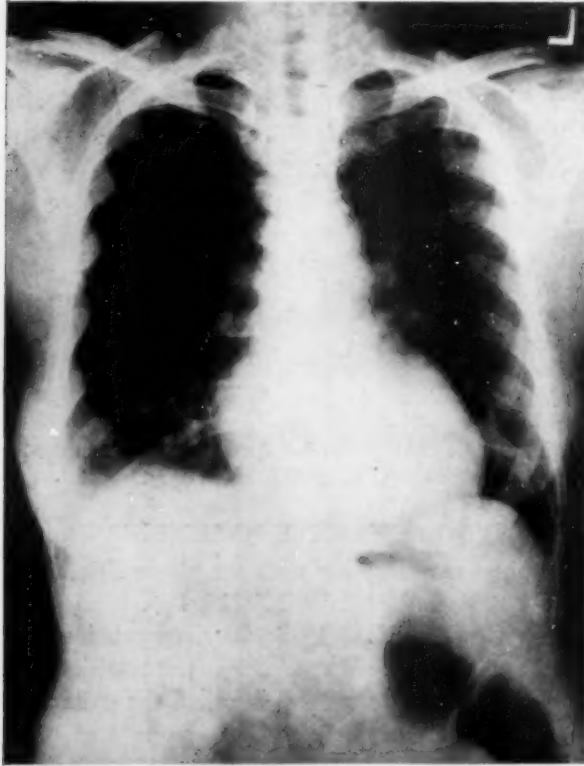ses of so-called post-operative pneumonia, but until recent years they had not really understood the underlying pathology in these patients. The X-ray appearance in massive atelectasis is quite distinctive and easily recognized. In examining numerous such cases they had only found massive atelectasis and lobar atelectasis occurring in relatively few patients. Since the recognition of this condition they had more or less routinely examined all post-operative cases that had shown evidence of pulmonary complications and had frequently detected a lesion at one or both bases which röntgenologically has the appearance of a bronchopneumonia. Recognizing, however, that

FIG. 1.—Bilateral Lobular Atelectasis.

these patients did not run a course typical of bronchopneumonia, they had attempted to conceal their ignorance by reporting such lesions as a pneumonitis. Through the work of Doctor Lee they now recognize these cases as lobular atelectasis. The Röntgen-ray features of lobular atelectasis are prominence of the trunk shadows and diffuse mottling throughout the involved area. (Figs. 1 and 2.) These areas are usually in the base of the lung and quite often bilateral. Likewise there may be some elevation of the domes of the diaphragm, and fluoroscopically one at times sees a restriction of motion of the diaphragm, and this motion is very apt to be jerky in character.

There is not often, however, a displacement of the heart which is characteristic of massive atelectasis.

Of necessity, post-operative cases must be exaamined in bed, and bedside films are never as satisfactory, as far as interpretation is concerned, as films made in the erect posture. The reason for this is that in bed, when the films are made, there is not complete æration of the lungs, and likewise the dome of the diaphragm is always higher in films made in this manner. It is very easy therefore to miss small patches of lobular atelectasis which are concealed by the dome of the diaphragm. In order to avoid such an error they routinely examine patients in the lateral position, as this is the best view for showing the posterior portions of each base.

Lobular atelectasis röntgenologically has practically the same appearance as bronchopneumonia, and they are not as yet able to differentiate these conditions but must depend largely upon the history of the case. The diagnosis is usually confirmed by the subsequent course of the condition inasmuch as these patients recover in a few days to a week. This recovery can be followed very nicely by subsequent X-ray examinations. Most of their post-operative patients have shown lobular atelectasis. This fact has led them to believe that the condition

FIG. 2.—Same Patient as in Fig. 1, Lateral View.

is far more common than is generally appreciated. With a view to establishing its frequency, they have recently asked permission of the Surgical Department of the University Hospital to examine routinely all post-operative cases in which an X-ray examination is not distinctly contraindicated.

In this connection he made a statement which is not generally appreciated by clinicians, and that is the fact that a bedside X-ray examination is less harmful and less detrimental to a patient and less disturbing than a properly conducted physical examination of the chest, so that there need be no fear of subjecting the recently operated patient to an X-ray examination.

Dr. W. J. M. Scott, Rochester, N. Y., remarked that most recent investi-

gators of massive atelectasis agree that there must be obstruction to the respiratory tree at some point. He differed from Doctor Lee in only one point, namely, that he believed that the obstruction arises originally in the bronchioles, or the finer respiratory passages ordinarily rather than in the main bronchus. Consequently he thought that bronchoscopic aspiration is unnecessarily severe.

Surgeons have now gone on to the stage of attempting to prevent massive atelectasis in these cases, and with some success. All of their patients having a general anæsthetic, all of their operative cases, are hyperventilated by carbon-dioxide at the end of the operation. In a series of 2,000 major operative cases under the previous régime, our incidence in Doctor Cutler's clinic was .6 per cent. of post-operative massive atelectasis, that is, the unilateral variety about which there is no question at all in the diagnosis. After the institution of hyperventilation at the end of operation by means of carbon-dioxide inhalation, the incidence has been reduced from .6 per cent. to .2 per cent. While he did not believe that this will entirely prevent all instances of massive atelectasis, it will definitely diminish their incidence.

TRAUMATIC EMPHYSEMA

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AND

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The subject of traumatic or surgical emphysema is rather casually touched on in most text-books on surgery. Articles in the literature within the last few years have largely been of isolated or small groups of case

Fig. 1.—Extensive emphysema of upper part of body following mediastinal escape of air.

reports, which have as their etiological factor some other cause rather than ordinary accidents resulting in injuries to the lung. The opportunity of seeing a group of cases over a short period of time having different types of chest injuries with varying pathological results, stimulated our interest in this subject and the treatment in two of these cases, varying from that recommended in most text-books, seemed to make it worth while to briefly review this subject.

The term subcutaneous emphysema has been avoided, as while part of the symptomatology is due to a subcutaneous collection of air in the tissues, in the cases observed, the radiograph showed that a large amount of the air was interstitial or beneath the fascial planes as well as in the subcutaneous tissue, and the spread through the tissues seemed to be modified according to which layers of fascial planes limited the extension of the emphysema. The emphysematous condition of the tissues is only part of the pathological lesion, and in the series of cases observed, it occurred with or without a pneumothorax, and with or without a penetrating wound of the chest.

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It was due to a lesion of the cortical surface of the lung, caused in one instance by a stab wound of the chest penetrating the lung and in another by a fractured rib with no external injury. In another patient it resulted from a crushing accident where quite obviously air had escaped from some deep injury to the air vesicles in the region of the hilus, traveling up the mediastinal tissues into the neck and from there spreading throughout the tissue planes between the muscles and under the skin, over the whole body. In contrast to this latter case, a child who received a similar crushing injury from an automobile accident had a pneumothorax with absolutely no evidence of emphysema.

Beside those cases of traumatic emphysema caused by crushing or penetrating injuries of the chest which damage the lung, many other factors are

FIG. 2.—Lower part of body of same patient.

listed in the etiology of this condition. Cases are reported as occurring during labor, following tonsillectomy, occurring as a result of fracture of the nasal bones, perforating duodenal and gastric ulcers and injuries to the retro-peritoneal surface of the duodenum or colon, and as a result of injury to the lung while performing an artificial pneumothorax, or aspiration; and in the administration of anæsthesia by the direct insufflation method. A series of cases secondary to pneumonia which occurred during the influenza epidemic of 1918, have also been reported. It is rather interesting to observe that, in certain lacerated wounds of the extremities, air may be sucked into the tissues, probably by the sliding action of the tissue planes, and air has been introduced into the tissues while giving a hyperdermoclysis, which might cause the presence of a gas bacillus infection to be suspected. Only those cases due to chest injuries will be considered in this article.

Pathology.—The mechanism of the entrance and diffusion of the air into the tissues apparently is due to the escape of this air from an injury

of one or more of the air vesicles, either on the surface of the lung or in the neighborhood of the hilus. This is most frequently seen where a fractured rib has lacerated the lung cortex and overlying, as well as the parietal, pleura. In such a case it can be easily understood how this air may be gradually pumped into the tissue planes covering the chest wall and thus spread a varying distance throughout the body. Several of the text-
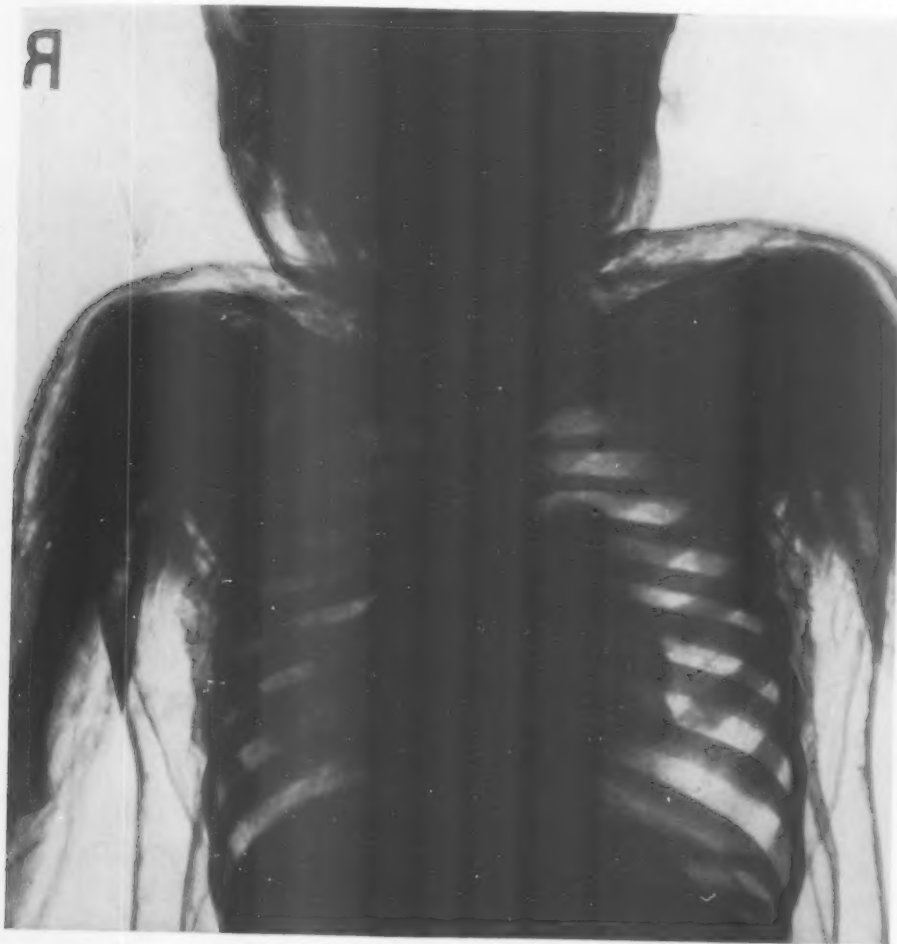

FIG. 3.—Radiograph of upper part of body same patient. Note pneumothorax.

books on surgery repeat the old statement, as to etiology, made many years ago by McEwen who found in one case, that a roughened fragment from a fractured rib had pierced the surface of the lung which remained hooked over this sharp fragment, and allowed the air to escape into the tissues. This, however, is probably a rare condition. In one case which is reported here-with, the radiograph shows the air extending upward through the mediastinum into the tissues of the neck. The patient, a small boy, when seen by the ambulance surgeon a few minutes after his accident, already had a marked

emphysema over the face and neck and upper part of the trunk, the eye-lids being so emphysematous that they were closed. (Figs. 1 and 2.) Subsequent X-ray showed a collapsed lung with a pneumothorax, but the existence

Fig. 4.—Radiograph of lower part of body same patient.

of the collapsed lung did not prevent the extension of the emphysema. (Figs. 3 and 4.)

In one case of traumatic emphysema, due to a stab wound of the chest wall penetrating the lung, the emphysema spread more slowly but there was no pneumothorax and the surface of the lung when cut down on seemed to be in contact with the parietal pleura. In a contrasting case of injury to

the chest, accompanied by a cerebral concussion and multiple contusions, the radiograph showed a pneumothorax but no evidence of emphysema. In another case of emphysema due to a fractured rib, the most common cause of surgical emphysema, it would appear that some injury of the lung surface and both layers of the pleura must have occurred, there being no external injury.

There seem to be two types of injury resulting in traumatic emphysema, which the above cases typify. First, those in which there is an injury to the chest wall, either from a fractured rib or a penetrating wound which results in an escape of air into the tissues of the chest wall at the site of injury. Second, those cases in which the chest injury results in a rupture of some of the air vesicles in the neighborhood of the hilus of the lung, and through which the air escapes into the mediastinum and spreads upward into the neck and then through the body. The mechanism of the escape of air from the vesicles of the lung through the mediastinum and thus into the tissues through the extra-pleural route, has been well demonstrated by Berkeley and Coffen.[1] During the 1918 epidemic of influenza they

FIG. 5.—Photograph of patient four months later. Note four scars of incisions.

had under their care in an army camp, 1,701 cases of broncho-pneumonia. Of these, nine cases developed a generalized interstitial emphysema and spontaneous pneumothorax. There were two other cases, following operation for empyema, developing a similar condition after operation in which the development seemed to be unrelated to the operation. The emphysema was always first observed at the episternal notch or above the clavicle. By means of X-ray studies and autopsy they were able to show ruptured air sacs in the

neighborhood of the hilus of the lung, followed by "air streaks" developing along the blood-vessels to the posterior mediastinum, then extending to the superior mediastinum and along the larger blood-vessels under the fascial planes to the neck and axilla. A valve-like action where the bronchiole entered the air sac, kept up a constant supply of air to be pumped into the tissues. In such cases the air distends the mediastinal tissues, making pressure on the large veins of the thorax.

The extension of the emphysema depends on both the amount of escaping air and its limitation by the fascial planes. In some cases the spread stops along the lower margin of the jaw and does not extend into the face, although distending the tissues of the neck. It may stop at Poupart's Ligament in the groin and not enter the thighs although the scrotum may be markedly distended. In severe cases where it follows the deep fascial planes, it extends from the scalp to the soles of the feet and lies not only subcutaneously but surrounds the various muscles as is very well shown in Figures 3 and 4.

Symptoms.—The symptoms of the emphysema itself are characterized by the crackling due to the air in the tissues which is only part of the clinical picture, the general symptomatology of the patient depending on the amount of lung injury, pneumothorax, possible infection and other traumatism accompanying the original accident. The presence of a pneumothorax is sometimes difficult to determine without a radiograph, as the air in the chest wall may muffle the respiratory sounds and even in the absence of a pneumothorax give an exaggerated tympanitic note on percussion. That this is caused by the air in the subcutaneous tissues may be proved by percussing over an area such as in the lumbar region which is normally dull but which, in the presence of marked emphysema of the tissues, will give quite a tympanitic note. Over the areas of emphysema there is pain and tenderness on pressure. Perhaps the emphysema alone is not the cause of death nor does it add greatly to the severity of the symptoms.

Sauerbruch,[2] however, as early as 1908, reported a case in which after a crushing injury of the chest, resulting in a severe general emphysema, the air escaped by way of the mediastinum. He observed that the distention of this region caused much pressure on the veins of the chest with marked congestion, especially of the inferior vena cava. He operated on this case in his negative pressure chamber and noted that after the "cutaneous" incision the emphysema of the tissues disappeared within a few minutes. He then opened the chest and observed the general improvement which occurred in the patient on the escape of air from the mediastinum. He states, however, that the patient died later. Tiegel [3] successfully treated a case of mediastinal emphysema by making a 4 centimetre incision in the episternal notch down to the trachea and applied continuous suction by means of a glass bell placed over the wound with 30 millimetres of negative water suction for five days. It is, therefore, reasonable to suppose that in a patient suffering from an injury to the lung, with or without other body injuries, the pain and embarrassment to circulation and respiration caused by the marked distention of

the body tissues with air may have considerable influence on the recovery or process of convalescence. This embarrassment would be more severe if there were a marked emphysematous condition in the mediastinum.

Treatment.—In most text-books on surgery, it is stated that the emphysema requires no treatment as it is self-limited, and while puncture of the subcutaneous tissues is suggested in the very severe cases, it is usually advised against because of the danger of infection. It is true that in most cases the air will be absorbed, but in the case of a patient whose symptoms appear to be getting worse and the emphysema spreading, it has seemed to us justifiable and wise to limit this spread if it can be done without injuring the patient. This is our excuse for presenting this article.

The case reported, a boy in whom the air escaped along the mediastinum from a deep lung injury and in whom the eyes were closed and the face, neck and trunk markedly distended within a few minutes after his injury, was watched for forty-eight hours before anything was done. At the end of forty-eight hours he appeared to be getting worse. It was then decided to relieve this distention by incision into the tissues. Two cuts were made parallel with the ribs on each side of the chest, with the escape of a very considerable amount of air and an immediate improvement in his symptoms. While it might be that this boy would have recovered without this therapeutic measure, he had continued to get worse until it was done, and his marked improvement was so coincident with the relief of the emphysema that it is believed it was a life-saving measure in his case.

In a second case, a woman had received a stab wound in the fifth intercostal space just internal to the posterior margin of the scapula. There was an increasing emphysema of the chest wall which had spread along the abdominal wall on that side as far as Poupart's ligament. While this woman's condition did not appear to be dangerous, in view of our experience with previous cases, it seemed wise to attempt to limit the spread of this emphysema. This was accomplished by cutting down, under local anæsthesia, along the line of the stab wound as far as the pleura, the wound being packed with iodoform gauze through the existing opening of the pleura, thus making impossible further escape of air into the tissues. There was no further spread of the emphysema. At the end of a week there was still an accumulation of air in the tissues as far down as the left inguinal region. This area was tender on pressure and caused pain on movement in bed. For the purpose of relieving this pain and tenderness, a small incision was made, under local anæsthesia, over this area and the air was found not in the subcutaneous tissues, but lying under the deep fascial planes. The air escaped through the incision, the wound was lightly packed and the pain and tenderness almost immediately disappeared, the wound healing rapidly.

Aspiration of the chest or introduction of a suction apparatus has been advocated in severe cases of emphysema, accompanied by pneumothorax. It would appear to us that during the time that the emphysema is spreading, this would not be good treatment. If the aspiration or suction were sufficient to expand the lung it would keep open the wound or opening in the lung through which the air escaped, and in those cases where severe lung injury were present, accompanied by hemorrhage, would promote the continuance of the hemorrhage. This opinion would appear to be borne out by two of the cases reported by Berkeley and Coffen in which the emphysema appeared at the episternal notch and above the clavicles after operation for empyema. It is a fair assumption in these cases that the relief of pressure

on the lung allowed the escape of the air into the mediastinum, and that a similar result would follow aspiration or suction treatment of the pneumothorax where this was accompanied by an interstitial emphysema traveling along the extra-pleural route from the hilus of the lung.

It is not intended that these two forms of treatment be applied to all cases of traumatic emphysema. However, it is our belief that relief of symptoms, prevention of the spread of the emphysema and perhaps saving of life may result from employing these methods in certain cases, rather than following the advice of doing nothing as appears in most text-books, where the danger of infection following small incisions under local anæsthesia is warned against, as it might have been in preantiseptic days from which this lack of treatment has probably been handed down.

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DR. EMMET RIXFORD, San Francisco, Cal., said that inasmuch as Doctor Douglas had mentioned several forms of acute subcutaneous emphysema independent of wounds of the lung, he might mention two in which air was left in the abdomen, probably as a result of elevating the edges of the wound in order to lessen the trauma of reintroducing the intestines. A considerable amount of air was left in the abdomen, and this after a few days gradually percolated out between the stitches, and not an extensive but a very definite subcutaneous emphysema occurred in the abdominal wall, so much so as to make them fear infection by the Welch bacillus or with some of the intestinal anaërobes, but the matter cleared up in both cases very promptly.